CHOCOLATE AND CONFECTIONERY

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AND

CONFECTIONERY

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by

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PREFACE

This treatise has been prepared as an up-to-date textbook for technical students undertaking courses in chocolate and confectionery production, as a reference for personnel already engaged in the industry, and as a broad survey for interested plant engineers.

The intelligent application of scientific methods and principles in the chocolate and confectionery industry is fully appreciated in the modern age, and inefficient productive methods can no longer be tolerated. The rapid development of machinery and scientific control instruments compels the progressive manufacturer to review his position in the competitive field in order that he may not be handicapped by outmoded plant and methods. As the standard of living in all countries is being raised so must the producer decrease his production costs by the introduction of efficient plant and scientific control to mass produce high-grade merchandise with the minimum amount of waste. The margin of error due to the variability of human concentration must be reduced to an absolute minimum.

The plant described in this book is the most up-to-date at the time of writing, but, as plant manufacturers are constantly improving on current design, many of these machines may be superseded. The question of ultrasonics and the effect of this science on methods of manufacture give rise to interesting possibilities in the future, and developments should be carefully watched.

The representative formulæ given are drawn from practical experience. Variations of composition, flavour and texture are practicable, providing the characteristics of the materials are fully understood.

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The British "Rema" Mfg. Co. Ltd. Fig. 63.
The Malmö Chokolad. and Konfekt-Fabriks Aktiebolag. Figs. 78a, 78b.
The Philips Electrical Ltd. Fig. 73.

CONTENTS

CHAPTER PAGE

I. A BRIEF HISTORY OF CONFECTIONERY THROUGHOUT THE AGES - - - - - - - - 19

II. SUGARS - - - - - - - - 29

Grades and types of refined sugar—Application to sweet manufacture—Refined soft sugar—Sweetness and flavour values—Syrups—Need for world standardisation of grades—Testing relative values of refined soft sugars—Sources of sugar—Extraction of sugar from cane—Clarification—Sedimentation—Filtration—Evaporation—Crystallisation—Black strap molasses—Refining—Affination—Melting—Decolorisation—Concentration—Separation of crystals—Drying and screening—Weighing—Sucrose content of sugar beet. *Maple sugar*—Extraction—Flavour value. *Corn syrup*—Characteristics—Control of crystallisation in confectionery—Method of manufacture. *Dextrose*—Method of manufacture. *Dextrose hydrate*—Method of manufacture—Properties—Value in fondant manufacture—Comparative effects of Dextrose and Sucrose on boiling point—Analysis of dextrose hydrate. *Lactose*—Source and method of preparation—Whey concentrate. *Invert sugar*—Method of preparation—Characteristics. *Caramel*—Method of manufacture—Colouring value.

III. SCIENTIFIC CONTROL - - - - - - 38

The importance of instrumental control—Temperature, humidity and density control—Instrumental check—Viscosity determination—MacMichael torsion viscometer—Working principle—Use in chocolate viscosity tests—Wire conversion factors—Care of wires—Particle size testing—Baker micro-projector—Description of apparatus—Ocular micrometer—The micron—Chocolate testing—Determination of *p*H—Marconi *p*H meter—Method of testing *p*H—Buffer solution—Determination of soluble solids—Refractometer—Description of instrument—Use in pectin jelly manufacture—Determination of gelatin strength—Bloom gelometer—Procedure—Establishment of standard practice—Working principle of gelometer—Determination of sugar content—Saccharimeter—Arrangement of parts in simple polarimeter—Polarisation of sugar solutions—Equations—Conversion of readings—Determination of moisture content—Method—Colorimetry—Lovibond tintometer—Principle of comparison—Precautions—Duboscq colorimeter.

CHAPTER PAGE

IV. COLLOIDS - - - - - - - - 47

Importance of colloids—Research—Gum tragacanth—Source—Properties—Precautions in treatment—Storage—Gum arabic—Source—Collection—Precautions in use—Gum chicle—Source—Properties—Substitutes—Gelatin—Source—Precautions in treatment and storage—Agar-agar—Source—Properties—Storage—Pectins—Source of citrus pectin—Manufacture—Properties—Effect of *p*H on pectin—Testing end point—Egg albumen—Source—Testing samples—Storage—Soy albumen—Source—Properties—Method of using flours—Soya bean flour—Extraction—Usage—Wheat flour—Uses in licorice—Corn flour—Uses in confectionery—Grades—Modified corn starch—Fluidity—Effect of *p*H on gelling strength—Fluidity values in gums, jellies and Turkish Delight—Potato starch—Difference between Farina and potato starch—Uses in confectionery—Storage of flours.

V. RAW MATERIALS - - - - - - - 56

Essential oils and essences—Typical formula—Peppermint oil—Source—Properties—Spearmint oil—Source—Use in confectionery—Storage—Floral attars—Source—Attar of Rose—Adulterants—Musk—Synthetic attars—Citrus oils—Lemon oil—Comparison of method of extraction—Vanillin—Source—Method of extraction—Sources of synthetic vanillin—Properties—Coumarin—Source—Uses in confectionery and chocolate—Precautions—Storage—Fruit juices—Methods of extraction—Preservatives—Storage—Concentrated fruit juices—Advantages of usage—Borneo tallow—Source—Illipé butter—Properties—Cacao butter—Substitute—Coconut oil—Hydrogenation—Other vegetable oils—Palm, groundnut and cottonseed oils—Melting points—Confectionery fats—Effect of melting point on masticity—Synthetic fats—Citric acid—Source—Preparation—Purification—Tartaric acid—Source—Preparation—Use in confectionery—Glacé cherries—Method of preparation—Colouring—Syruping—Grading—Navarre continuous process—Nuts—Source—Coconut—Copra—Storage—Prevention of insect infestation—D.D.T. treatment—Licorice—Source—Extraction of by-products—Dried fruits—Source—Prevention of insect infestation—Fumigation—Packing—Storage—Milk—Condensed milk—Desiccated milk powder—Testing—Storage problems—Sugar content—Bacterial count—Moisture content—Insolubility—Effect on nutritive value—Storage—Lecithin—Source—Method of recovery—Effect on viscosity—Prevention of sugar bloom.

VI. CHOCOLATE AND CONFECTIONERY PLANT - - - 78

Chocolate producing plant—Cacao bean cleaning and grading machine—Removal of foreign matter—Method of

CHAPTER PAGE

VI—*contd.* operating—Separations—Capacity—Unit roasters—Sirocco-type—Gas or coke fired—Principle—Method of operating—Continuous roasters—Principle—Cooling system—Degree of roasting—Capacity—Steam roasters—Principle—Control of roast—Husking and winnowing machines—Constructional material—Method of operation—Germ separator—Secondary winnowing—Principle—Grinding—Vertical liquor mills—Grinding disc principle—Horizontal triple mills—Method of operation—Hydraulic cacao butter press—Mixers—Vacuum kneader—Melangeurs—Steel bed melangeur—Principle—Automatic discharge—Evaporation and vacuum drying plant—Capacity—Refining—5-Steel roll refiner—Principle of operation—Safety measures—Lubrication—Conching—Longitudinal conche—Principle—Capacity—Temperature control—Circular conche—Reduction of conching time—Discharge—Capacity—Other types—The Aasted conche—Principle of operation—The Aasted Aggregate—Conche—Plasticator—Refiner—Mixing tank and storing tanks—Principle of operation—Operational control—Storage—Precautions—Ultrasonic conching—Principle of operation—Effect of ultrasonic oscillation on chocolate mass—MacIntyre chocolate machine—Principle of operation—Capacity—Chocolate tempering—Melting kettles—Thermostatic control—Chocolate coating—Greer enrober—Pre-bottoming attachment—Elimination of tailings—Greer refrigerated cold slab—Greer chocolate enrober—Essential features—Greer Hi-gloss cooling tunnel—Cooling system—Principle of operation—Greer multi-tier cooler—Method of operation—Filled plaques—Return of empty trays—Space advantage—Chocolate decoration—Lehmann automatic decorator—Latini automatic decorator—Description—Refrigerating plant precautions—Conveyor packing—Chocolate moulding plant—Jensen automatic moulding plant—Capacity—Unit depositor—Fantafilla model—Principle—Capacity—Cocoa powder production—Rema automatic cocoa powder plant—Description—Grinding—Cooling—Control of fineness.

SUGAR CONFECTIONERY PLANT - - - - 92

Hard sugar goods—Continuous vacuum sugar cooker—Principle of operation—Capacity—Vacuum batch cooker—Hansella model—Principle of operation—Non-vacuum continuous cooker—Baker Perkins microfilm continuous cooker—Principle of operation—Batch cooling and tempering—Horizontal batch roller—Rope forming and sizing machine—Rostoplast moulding machine—Cooling system—Soft centre filler—Seamless tablet moulder—Hollow-sleeve drop rollers—Bartleet model—Equalising rollers—Cooling system—B.C.H. Lollipop attachment—Automatic balling machine—Bartleet model—Principle of operation—Cooling

CHAPTER PAGE

VI—*contd.* system—Capacity—Buttered goods—Essential plant—Gas cookers—Dipping tables—Candy pulling machines—Continuous fondant plant—Principle of operation—Capacity—Care of Mogul starch machine—Principle of operation—Oka paste machines—Starch trays—Unit starch machine—Oka paste depositor—N.E.C. hydro-seal pump bar—Principle of operation—Gum cleaning and crystallising—B.C.H. gum steaming machine—Dry crystallising—Syrup crystallising—Baker-Hulme crystallising plant—Marzipan production—Essential plant—B.C.H. blanching machine—Refiner—Cooker—Automatic grading, scalding, draining and blanching plant—Automatic almond splitting—Capacity—Starch conditioning—Gardner quick change dresser—Cleaning—Principle of operation—Starch dryer—Drying stoves—Construction essentials—Hot air system—Nougat production—Nougat beaters—Cutting machine—Marshmallow beaters—Capacity—Albumen whisk—Precautions—Toffee and caramel production—Types of steam stirring pans—Vertical mixer—Under-driven mixer—Capacity—Precautions—Caramel brakes—Cutting machines—Slab cutters—B.C.H. batch leveller—Licorice production—Heavy duty cooking pans—Paste refiner—Extruding machines—Principle of operation—Capacity—Drying—Cutting—Guillotine—Lozenge production—Lozenge pinning, printing, embossing and cutting machine—Principle of operation—Capacity—Cachou cutting—Compressed lozenge machine—Principle of operation—Capacity—Paste mixing and sizing—Dragée production—Revolving pans—Air ducts—Silver dragées—Glass revolving pans—Drying stoves—Chewing gum production—Heavy duty mixers—B.C.H. thicknessing, forming and cutting machine—Principle of operation—Adjustments.

CHOCOLATE AND CONFECTIONERY WRAPPING MACHINES - 107

Hard sugar moulding and wrapping—Forsella plastap machine—Capacity—Twist wrapping—Forgrove model—Capacity—Fold wrapping—Registration device—Wrapping irregular shapes—Lauenstein universal wrapping machine—Principle of operation—Capacity—Forgrove universal wrapping machine—Crimp and sachet wrapping—Capacity—Bar foiling and banding—Forgrove model—Photo-electric cell registration—Foil economy—Capacity—Liqueur wrapping—Sapal model—Capacity—Roll wrapping—Forgrove model—Principle of operation—Capacity—Automatic weighing and filling—Southall and Smith machine—Powder weighing and filling—Principle of operation—Capacity—*Sugar pulverising*—Micro-pulveriser—Micro-atomiser—Operational principle—Pin-disc milling—Kek mill—Principle of operation—Capacity—Plant development.

CHAPTER PAGE

VII. HARD SUGAR GOODS - - - - - - 113

The function of "doctors"—Cream of tartar—corn syrup—Invert—Packaging—Precautions, formulæ and processes.

VIII. CHOCOLATE - - - - - - - - 118

Cacao beans—Selection—Tabulated varieties—Plant diseases—Treatment of raw beans—Flavour of beans—Cleaning and grading—Roasting technique—Blending—Grinding—Mixing—Vacuum drying of milk chocolate mass—Refining—Conching technique—Degree of fineness—Micro-projector—Effect of fineness on gloss—Flavours—Viscosity—Tempering—Enrobing—Temperature control—Temperature of centres—Cooling temperature—Humidity—Air-conditioning—Handling chocolates—Precautions—Centres containing oils—Milk chocolate—Blockmilk process—Analysis of Blockmilk—Technique of cooling—Removal of latent heat—Cooling time—Bloom—Chocolate moulding—Temperature and humidity control—Formulæ—Processes. *Cocoa Powder Production*—Technique of alkalisation—Pressing—Cooling—Cake-breaking—Pulverising—Packaging—Precautions—Control of flavour—Chocolate powder—Cocoa powder mathematics—Formulæ and processes.

IX. TOFFEES, CARAMELS AND FUDGE - - - - 135

Creamy toffee—Use of colloids—Balance of composition—Formulæ and processes—Caramels—Fudges—Frappé.

X. NOUGAT AND MARSHMALLOW - - - - 142

Characteristics—Texture—Albumen nougat—Gelatin nougat—Formulæ and processes—Marshmallow—Schaum mallow.

XI. DRAGÉES - - - - - - - - 149

Technique—Formulæ and processes—Sugared almonds—Gumming—Grossing and bulking—Whitening—Filling—Polishing—Inspection—Chocolate coated dragées—Glazing—Silvered and gilded dragées—Centres—Tabulated relative coating quantities to size of boule—Silvering process—Polishing—Storage—Lower grades of dragées—Use of flours—Precautions—Soft sugar coating—Process—Glazing—Hard butter coating—Polishing—Beeswax—Spermaceti—Nonpareils—Process—Pearled goods—Method of pearling—Glazing—Imitation petals.

XII. LOZENGES AND CREAM PASTE - - - - 158

Cohesive content—Invert content—Formulæ and processes—Lozenges—Drying—Compressed lozenges—Cachous—Floral attars. *Cream paste*—Formulæ and processes—Coconut paste—Licorice paste—Function of wheat flour and gelatin—Chewing gum—Method of manufacture—A suggested new confection.

CONTENTS

CHAPTER PAGE

XIII. FONDANT - - - - - - - - - 167

Technique of fondant—Control of crystallisation—Invertase—Effect of temperature—Fondant base—Dextrose hydrate—Cast cream centres—Syrup bob—Fourrés—Crystallising.

XIV. PASTILLES, GUMS AND JELLIES - - - - - 171

The function of gelatin—Agar-agar—Gum arabic—Citrus pectin—Modified starch—Manufacturing precautions—Pectin gels—Refractometer testing—Formulæ and process—Hard gums—Gelatin gums—Pastilles—Agar fruit jellies—Packaging—Citrus pectin jellies—Precautions—Use of waste—Acidulated jellies—All starch gums—Precautions—All starch jellies—Dessert figs—Packaging—Precaution—Turkish Delight—Packaging—Gelatin lozenges—Liqueurs—Piping jelly—Utilisation of waste—Formula and process.

XV. MARZIPAN - - - - - - - - - 184

Types—Formulæ and processes—German method—Crystallising—Pre-cooking method—Marzipan fruits and mosaics—Method—Almond substitutes. *Praline*—Base—Formulæ and processes—Milano chocolate paste—Noisettes—Liqueur flavours—Precautions—Nougatines—Storage—Imitation nougatines.

XVI. FACTORY ORGANISATION - - - - - - 190

Planning the factory—Accessibility to services—Reduction of cleaning costs—Installation of plant—Chocolate conveying—Streamlined plant—Motion study—Factories Act (1927)—Safety measures—Plant maintenance—Scientific influence on technique—Laboratory control—Prevention of waste—Plant hygiene—Electronic inspection—Radio frequency heating—Elimination of infestation—X-rays inspection—Quality control—Production planning—Influence of colour—Air conditioning—Human factor—Delivery.

XVII. RESEARCH - - - - - - - - - 202

New materials—Hydrogenation—Plastics—Whey concentrate—Food values—Dextran—Package design—Colour scheme—Pre-packing—Ultrasonics—Emulsification—Particle comminution—Co-ordination of research.

INDEX - - - - - - - - - 214

ILLUSTRATIONS

FIGURE PAGE

1. Sugar Packeting Department - - - - *Facing* 32
2. Centrifuges in Sugar Factory - - - - ,, 32
3. Liquor Room in Sugar Factory - - - - ,, 33
4. Testing Degree of Fineness with a Micro-Projector - ,, 33
5. B.-S. Projection Refractometer - - - - ,, 48
6. B.-S. Polarimeter - - - - - - ,, 48
7. Specimens of Agar - - - - - - ,, 49
8. Hydrogenation Plant: Line Drawing - - - 61
9. Refrigeration Plant - - - - - - *Facing* 64
10. Hygienic Date Packing in California - - - ,, 65
11. A Battery of Milk Condensers - - - - ,, 65
12. Spray Drying Plant: Line Drawing - - - 68
13. A Line Drawing of the Rotary Louvre Continuous Bean Roaster 72
14. Aasted Conche: Line Drawing - - - - 80
15. Micrographs of Crystals in Condensed Milk - - *Facing* 80
16. The Milk Testing Section of the Hershey Works Laboratory ,, 80
17. Sirocco-Type Roaster - - - - - - ,, 81
18. Horizontal Triple Mills - - - - - - ,, 84
19. Carver Hydraulic Cocoa Presses - - - - ,, 85
20. Greer Multi-Cooler Mechanism: Line Drawing - - 88
21. H.M.S. Chocolate Melangeur - - - - *Facing* 92
22. Davy Vacuum Dryer for Milk Chocolate Mass Drying - ,, 92
23. B.P. 5-Roll Refiners - - - - - - ,, 93
24. Longitudinal Conche - - - - - - ,, 93
25. H.M.S. Circular Steel-Bed Conche - - - - ,, 100
26. Aasted Conching Aggregate - - - - - ,, 100
27. Aasted Plasticator - - - - - - ,, 101
28. Automatic Tempering Machine - - - - ,, 101
29. McIntyre Chocolate Machines - - - - ,, 108
30. Greer Pre-Bottomer - - - - - - ,, 109
31. Greer Chocolate Enrober - - - - - ,, 109
32. Kek Mill : Line Drawing - - - - - 111
33. Greer Hi-Gloss Cooling Tunnel - - - - *Facing* 116
34. Greer Multi-Tier Cooler - - - - - ,, 117
35. A Curve Illustrating Temperature Control - - 124
36. Jensen Chocolate Moulding Plant - - - *Facing* 124
37. Bar Moulding Plant - - - - - - ,, 124

FIGURE PAGE
38. Microfilm Cooker - Facing 125
39. Batch Roller, Sizer and Rostoplast ,, 125
40. Soft Centre Filler, Batch Roller and Rostoplast ,, 128
41. B.C.H. Hollow Sleeve Rollers ,, 128
42. Master Starch Machine ,, 129
43. Battery of Steam Stirring Pans ,, 132
44. B.C.H. Toffee Cooling Plates ,, 133
45. B.C.H. Toffee Cutting Machine ,, 140
46. Battery of Dragée Pans ,, 140
47. B.C.H. Lozenge Machine ,, 141
48. B.C.H. Gum Cleaning and Crystallising Machine ,, 144
49. Drying Stoves ,, 145
50. Albumen Whisk ,, 145
51. B.C.H. Chewing Gum Cutting Machine ,, 150
52. Lauenstein Universal Foiling Machine ,, 150
53. Battery of Bar Foiling Machines ,, 151
54. Interesting Foiling Machines ,, 154
55. 3 TH Mikro-Pulveriser ,, 155
56. Hard Candy Sorting Department ,, 155
57. Natives Extracting Beans ,, 160
58. Disease in Cacao Trees: Club Root ,, 160
59. Enrober Room ,, 161
60. Semi-Automatic Filling Machine ,, 161
61. Egg-Mould Spinning Machine ,, 176
62. Hand Foiling Easter Eggs ,, 176
63. British "Rema" Continuous Cocoa Powder Plant ,, 177
64. Cocoa Cake Extraction ,, 180
65. Powder Fillers ,, 180
66. Paste Mixers ,, 181
67. Confectionery Packing Department ,, 181
68. Sorting and Weighing Candies ,, 188
69. Weighing and Packing Confectionery ,, 189
70. Electronic Inspection Unit: Line Drawing 194
71. Macro 100 Inspection Unit: Line Drawing 196
72. Rotary Top Closure Machine - Facing 196
73. Unique Types of Twist Wrapping ,, 196
74. Carton Design ,, 197
75. Air Cooling System: Line Drawing 199
76. Air Washing Plant: Line Drawing 200
77. Distinctive Package Designs - Facing 204
78. (A) and (B) Micrographs of Chocolate Treated in Ultrasonic and Longitudinal Conches 205

CHAPTER I

A BRIEF HISTORY OF CONFECTIONERY

THE chocolate and confectionery industry possesses an historical background reaching far back into antiquity. Its birth was coincident with the discovery by man of the sweetness of honey; its early development is recorded on stone tablets, in the Old Testament, and on papyri and parchment. As the cities of ancient civilisations are discovered and excavated, we shall learn still more of the sociological history of the inhabitants and perhaps the sweets they enjoyed.

In the year 1566 B.C., confectioners in Egypt were already engaged in the making of sweetmeats for their customers, selling their wares from baskets in the market places. Evidence of this fact is vouchsafed by a considerable number of references made to the art in hieroglyphic inscriptions excavated from the sites of ancient cities. At that time sugar, as we know it today, was unknown, and the sweetening basis of confections was honey. The honey was mixed with chopped fruits, such as dates and figs, and kneaded into a paste which provided many palatable cakes of sweetmeat. Even today, honey is used in place of sugar in Turkish Delight made in Alexandria, Istanbul and other Middle East centres. Raw materials such as licorice juice, gum arabic and gum tragacanth were known to and used by the sweet makers in the B.C. era. Tragacanth is mentioned in the writings of Theophrastus in the third century B.C., and later by Dioscorides, a Greek physician of the first century A.D. The virtues of licorice were extolled in post-Vedic Brahman writings.

In later years the Romans and Greeks progressed still further and introduced a certain amount of manipulative and artistic skill into the trade. Excavations at Herculaneum, an old Roman city west of Vesuvius, revealed the complete equipment of a confectioner's workshop, which gave us an insight into the development already taking place.

Sugar, in crystalline form, was first produced from the cane in India at the dawn of the Christian era. It formed part of the tribute paid to the Emperor of China from the Indian border provinces. By A.D. 500 white sugar had been introduced into Persia and Arabia. The original Persian word for sugar was "kandisefid," whence we get our word "candy." "Shekar" was the East Indian word for it; hence "sugar." In A.D. 627, the time of the conquest of Dastagerd in Persia, sugar was among the spoils taken by the Byzantines, and, during the same period, the Chinese Emperor Tai Tsung sent emissaries to Behar in India to learn the art of sugar manufacture.

The sugar cane was taken by the Arabs to Sicily in A.D. 703, and the sugar made here was exported to Africa in the year A.D. 900. In the year A.D. 755 Abdurrahman took the plant to Spain, where it was cultivated on the coast of Andalusia. Egypt also made the acquaintance of the sugar cane at the beginning of the eighth century. The commercial manufacture and refining of sugar developed in Egypt during the ninth and tenth centuries, and its export formed an important part of that country's commerce. The Chinese were responsible for the cultivation of the sugar cane in Java and the Philippines.

The production of sugar was not restricted to the evaporation of the juice to dryness or syrup; the Arabs and the Egyptians learnt to purify raw sugar by recrystallisation, and made a variety of sweetmeats and preserved fruits. Amongst other materials, they made use of the gums indigenous to their countries to bind the powdered sugar into lozenges, and decorated ceremonial sweet cakes. In the eleventh century, returning crusaders brought back small quantities of sugar to their respective countries in Northern Europe.

Marco Polo visited China in 1270-95 and discovered a considerable number of sugar factories in Southern China, where the sugar could be purchased at a low figure. The Chinese made a form of preserves by stewing a mixture of fruits and sugar, the forerunner of our present-day jam.

Spain possessed a flourishing sugar industry in 1150, and as much as 75,000 acres were under cultivation. Production and consumption in the Mediterranean countries were more or less localised, and sugar was still a rarity in the more northerly European countries.

In 1200, a druggist of Verdun conceived the idea of coating almonds with a mixture of sugar and honey. In this manner the first dragée was evolved, although at the time it was called "épice." Subsequently, dragées were the vogue amongst the nobility, and were carried about in a sachet by the ladies of the period, and offered as titbits.

Preserved fruits in honey were produced in Europe in the reign of Charlemagne, at the beginning of the ninth century, chiefly in the Alpes Maritimes district of France. Later, on the introduction of sugar, the industry grew rapidly. In 1342, it is recorded that the reigning pope Clement VI of Avignon received an annual gift of preserved fruits from the town of Apt.

The earliest known record of the introduction of sugar to England is found in the year 1319, when a shipment was received in London in exchange for wool. For the same year, the accounts of the Scottish Chamberlain show that the cost of sugar was 1/9½ per lb. This was too expensive for general use, and furthermore, the quantities in the country were very small and little was known of its properties, all of which confined its use chiefly as a vehicle for drugs. Nevertheless, during the latter years of the fourteenth century, sugar was sold in increasing quantities, and used more freely by the cooks of that period. Medieval cookery books bear recipes for preserved Chinese ginger and candied orange peel, which were used as a finishing flavour for cooked partridge.

At the close of the fourteenth century, Europe had developed a flourishing trade in sugar. Venice remained the great central market until the early years of the fifteenth century, when Vasco da Gama made his memorable voyage around the Cape and discovered a water route to India, and opened up trading in sugar and spices. In 1492, the Genoese explorer, Columbus, also sought India. He, however, travelled westwards, discovered the New World and found the cacao bean, samples of which he brought to Spain for his sovereign Ferdinand V. He introduced the sugar cane into Santo Domingo in 1494, thence it was carried to Cuba, the West Indies and countries of South America. Sugar had become so important a commodity as an additional food at this time, that it supplied one of the motives which impelled Spain, France, England and other European countries to reach out after tropical and sub-tropical countries where it might be found. It might be mentioned that it was the insistent gastronomic demands of the nobility in the fifteenth century that spurred the imaginative faculties of their cooks, and it is to these worthy experimenters that we are indebted for the considerable progress made in the application of sugar to decorative forms.

The sixteenth century was a memorable period in the history of confectionery. Between the years 1453 and 1571, the Turks most foolishly succeeded in extinguishing the flourishing sugar industry throughout the Mediterranean and Middle East countries by destructive military invasions. The sugar industry had thus been transferred from the Eastern to the Western Hemisphere. By 1600, the production of raw sugar from cane in tropical America had become the greatest industry in the world.

Complementary to sugar sweetmeats which were being produced in greater variety in Europe, the existence of the actual cacao plant and the beverage made from its fruit was discovered by Hernan Cortez in 1519. A few years previously, Ferdinand V of Spain had received specimens of the cacao bean from Columbus, who was, however, unable to follow up the possibilities of the material. Before the arrival of the Spaniards in the New World, chocolate was one of the principal foods of the Aztecs in Mexico and the Incas in Peru. They prized the fruit of the cacao plant so much that the beans were used as currency. A drink composed of ground cacao beans was known as "chocolatl" in South America; it was flavoured with vanilla and other spices indigenous to that country. It was apparent from the knowledge displayed by the Aztecs that the tree had been cultivated for many generations. The Spaniards, having established the existence of the cacao plant, cultivated it in other of their possessions, and kept the method of cultivation and preparation secret for nearly 100 years. Chocolate, as a beverage, was introduced into Spain in the reign of Charles V (1500-58), and spread throughout Europe on the decline of Spanish power.

In England, sugar came into general use for cooking purposes and for conserves in 1576, and the chief type of confectionery made at that time consisted of gum-paste, a mixture of ground sugar and gum arabic, which was fashioned into ornamental shapes by ingenious pastrycooks. This art originated in the Middle East and was first introduced into Italy and France, but it is to the French that we are indebted for the development of the confectionery trade. The French chronicler, Bouquet, describes the gift of platters of fruits, viands and fish fashioned out of sugar, even to the platters, to Elizabeth of Austria, wife of Charles X, by the Town of Paris in 1571. Up to the end of the sixteenth century, confectionery was confined chiefly to this type of work owing to limitations of technical knowledge and materials. The work accomplished, however, showed considerable skill for that period.

The seventeenth century was a period of considerable progress in confectionery inventiveness. In 1600, a French confectioner produced the first hard-coated dragée by coating almonds with several layers of sugar syrup, each layer being allowed to dry before the addition of further charges of syrup. This was a great advance on the old method, and still holds good. In 1650, the praline was invented by a cook of the Mareschal du Plessis-Praslin, from whom this confection derived its name. This praline consisted of ground nuts and boiled sugar mixed to a paste, and was the basis of present-day manufacture.

In 1651, chocolate was introduced into France from Spain by Alphonse de Richelieu, Cardinal-Bishop of Lyons, brother of the great Cardinal Richelieu. In 1660, chocolate, consisting of a mixture of ground cacao beans and sugar, was manufactured on a considerable scale for the first time. Drinking chocolate had become popular in England, and the first chocolate drinking house was founded in 1657 at Bishopsgate, London. Chocolate houses became the rendezvous of society during that period; the most famous being White's Chocolate House, near St. James's Palace, and the Cocoa Tree Club in St. James's Street. In 1662, Henry Stubbe, an English physician, published a discourse on drinking chocolate, after he had paid a visit to the West Indies to investigate the physical effects of the beverage. The Diary of Samuel Pepys contained an entry describing his experience of chocolate drinking. Whilst in France, in the year 1664, chocolate was praised by learned academicians for its food value, presumably on account of its fat content, it was violently attacked by other writers because of its alleged debasement of the morals of those who drank it.

The whole of the raw cacao was imported by Spain from South America until the end of the seventeenth century, and English houses bought their chocolate already processed from Spain and France. This is confirmed by the fact that the import duties of the time were imposed on the finished product and not on the raw material. In 1660, a duty of 8d. per gallon was imposed in England on all chocolate made and sold, and in 1690, Parliament passed a law forbidding the drinking of chocolate without a licence. This coincided with the renewal of an edict in France, which had been passed in 1659, giving the monopoly of the sale of chocolate to a royal chocolatier, Chailloux-David.

Yet another type of confectionery, marzipan, was originated, this time in Germany. The first account we have of marzipan is in the year 1671, when a Doctor Buntekoë of Brandenburg ordered his cook, Franz Marzip, to make an almond dessert that could be served after dinner with a glass of white wine. The dessert was so popular that Marzip was promoted to the post of cook to the Elector. After Frederic Wilhelm's death, Franz Marzip returned to his home town, Lübeck, and founded a marzipan factory. Since that time, Lübeck has become world-famous for its marzipan products.

According to official documents, nougat was first created in Montèlimar in France in 1701. At the beginning of that year, the Ducs de Bourgogne and de Berry passed through Montèlimar on their return from Spain, and were presented with a gift of white nougat by the townspeople. In 1714, a similar gift of nougat was handed to the Persian Ambassador to France. The district has always been noted for its honey, which was, and still is, an important, if not essential, ingredient of nougat Montèlimar. The word "nougat" was derived from a legendary tale of Tante Manon, an elderly creature renowned for her confections. The many children who received her bounty used to say "Tante Manon, tu nous gâtes—you spoil us," and this confection was christened with the abbreviated "nougat." The ingredients used in 1701 consisted of sugar, honey, eggs, nuts and fruits.

It was not until the eighteenth century that the manufacture of chocolate was general in England and European countries. In 1728, serious production was commenced. It was in this year that one of the greatest English chocolate manufacturing houses laid the foundation of its business, and, a decade or so later, yet another English house commenced dealing in chocolate and cocoa. Addison wrote in 1711, "We repair our bodies by the drugs of America," by which he probably referred to chocolate. One of the first chocolate works in France was founded at La Fouillouse in 1770. Although the event caused quite a sensation at the time, all manufacture was accomplished manually.

In 1760, George Dunhill made the first licorice cakes in England, a combination of the juice of the licorice root and sugar, which proved extremely popular amongst the farmers and merchants of Yorkshire. Licorice root is a product of Asia Minor, and for centuries has been cultivated in the East, whence licorice confections really originated. During the eighteenth century, French confectioners achieved almost unbelievable skill in the production of decorative sugar confectionery mainly of allegorical design and representations of national events. They were sculptors in sugar.

Such work is, today, confined to ornamentation for celebration cakes and exhibitive purposes. In 1780, fancy confectionery boxes of elaborate design came into vogue in France: boxes which bore exquisite paintings, artistically embossed plaques in bronze and inlaid semi-precious stones. Even then, confectioners held definite ideas of shelf-appeal.

In England, at this period, unemployment, low wages and low purchasing power of money due to taxation and war expenditure increased the price of food, and the cost of all commodities rose considerably, which precluded much progress being made in the production of confectionery. Nevertheless, a number of sweet manufacturing businesses were established and many of them have survived and thrived to this day. The principal confections produced were boiled sweets, candied peels, sugar-coated almonds and various mixtures of nuts and sugar, which were offered in different forms, hand-moulded or cut pieces.

Hopjes, now known the world over by the name "Haagsche Hopjes," were first conceived at The Hague in Holland by Theodorus van Haaren in the year 1792. The idea was born out of a curious incident. An ambassador named Baron Hendrik Hop, who boarded in the van Haaren household, happened to be an inveterate coffee drinker. The baron was ordered by his doctor to give up coffee on account of his health, whereupon the baron asked his confectioner-landlord to make him a bonbon containing coffee essence. This van Haaren did so successfully that Baron Hop, in his enthusiasm, distributed the bonbons freely amongst his friends at court, who dubbed them with the name "hopjes."

Until 1795, the grinding of cacao beans and other pulverising processes in connection with sugar confectionery had been accomplished manually or by water-driven machines. In that year the steam engine, invented by James Watt in 1770, replaced them. The advent of steam power caused the chocolate and confectionery industry to progress rapidly.

In 1814, at Arles-sur-Tech, a chocolatier named Carbone installed a chocolate mill driven by water-power, and a mixing machine resembling the modern melangeur.

In the year 1815, Casparus van Houten requested of the Director of Excise authorisation to set up a chocolate mill in his house at Amsterdam. The factory was a very primitive affair, and the plant consisted of a roasting tin, an apparatus to break the beans, a sieve to remove the shell, and a mill to grind the nibs to liquor. No other power than manpower was available, therefore the pivot of the mill was kept in motion by labourers running around in circles. By 1822, however, the business had extended, and the now famous son of the founder, Coenraad Johannes van Houten, was taking an active part in the development. It is to the inexhaustible patience of C. J. van Houten that the world owes the discovery of cocoa powder and the revolutionary effect his discoveries had on the whole chocolate industry. The drinking chocolate of the time contained all of its natural content of butter, which was far too rich for comfortable assimilation, so the younger van Houten set out to extract as much of the fat as possible. After endless experiments he succeeded in expressing sufficient cacao butter out of the liquor, and treating the resultant cocoa powder to produce the first "soluble" cocoa. This took place in 1828. It was not until 1850 that universal manufacture of sweetened eating chocolate was carried out in the Western European countries. C. J. van Houten's process was adopted in England in 1866, and soon afterwards in Massachusetts, U.S.A.

Although a machine for the coating of dragées was introduced in France in 1840, it was not until 1858 that a satisfactory mechanical method of dragée manufacture was introduced by an extremely able dragée maker named Peysson, who was associated with a noted French confectioner, Jacquin. Peysson invented the revolving pan, which was fundamentally the same as it is today.

Gums and pastilles were first made in Asia Minor, where a mucilage of gums was mixed with a syrup of sugar and honey and poured into shallow vessels which were placed in the sun partially to dry out. The product, a gummy sheet, was cut into pieces and thrown into sugar. The method was introduced into France in the eighteenth century and developed in that country, where it became a monopoly. Gums and pastilles were first produced in England in 1879, a Frenchman named Claude Gaget being brought from France to produce these confections for one of England's foremost manufacturers.

A raw material of the utmost importance to the confectionery industry, sweetened condensed milk, was first produced in the United States of America just prior to 1860. The process was introduced into Switzerland by Charles A. Page, U.S. Consul, who formed the Anglo-Swiss Condensed Milk Co. in 1866, and commenced manufacture in the following year. This company was subsequently absorbed by the Nestlé organisation. Daniel Peter, a Swiss chocolatier, realising the possibilities of incorporating this form of milk in his chocolate, started a series of tests, and as a result was the first man to produce milk chocolate in solid form. This was introduced to the world in 1876. Hans Sloan is credited with the origination of a milk chocolate beverage, but Peters was without doubt the inventor of solid milk chocolate, in which he used sweetened condensed milk.

The caramel was introduced into North America by immigrants from Turkey and Eastern Mediterranean countries during the first half of the nineteenth century. Thence it was brought to England in 1882 by an American representative, R. S. Murray, who commenced caramel manufacture in London in 1883. Later, in 1892, John Mackintosh, seeking something new, evolved the cream toffee, a combination of sugar, butter, milk and German glucose. This was another milestone in the development of the industry.

Towards the close of the nineteenth century, developments in mechanical equipment and motive power enabled the chocolatier and confectioner to improve the texture and quality of their goods. Discoveries of new raw materials meant new variations of confectionery, and these began to appear in ever-increasing volume.

From 1900 to the present day the combination of scientific research, mechanical ingenuity and manipulative skill established the chocolate and confectionery industry as an important factor in the world's economy.

In time of war the industry suffers from shortage of raw materials and from the destruction, or loss through neglect, of sources of supply of those materials. On the other hand, in these recurrent crises, the high food value of chocolate and confectionery has been amply proven; scientific development has been accelerated resulting in the discovery of valuable substitutes and improved methods, and the greater realisation of the importance of the industry to the world's economy and well-being.

CHAPTER II

SUGARS

Sugar is one of the most important and valuable raw materials in the world. It is the mainspring of the chocolate and confectionery industry, and therefore demands an intensive study of its chemical and physical properties in relation to confectionery production to ensure the best possible results.

Grades and Types of Sugar

There are several grades of refined sugar, each of which has its own particular application to and effect on the character of the many types of confectionery manufactured. Even amongst the highest grade refined white sugars there are differences in the minute content of impurities in the mother liquor surrounding the crystals, which are capable of producing wide variations in the final product. For instance, a white refined sugar which might be ideal for the production of high-grade marshmallows would possibly be quite unsuitable for the manufacture of clear crystal mints. Such differences must be known to the confectioner when purchasing sugar for specific merchandise, and in this matter the advice and knowledge of the sugar chemist is invaluable.

Refined Soft Sugars

In the case of refined brown sugars, the increasing intensity of flavour so desirable in many types of confectionery depends on the increasing amount of impurities present in the mother liquor surrounding the crystals. As the degree of refinement decreases, so does the flavour increase, and we get a series of graded refined sugars of definite sweetness and sweetness plus flavour values from which selection may be made to meet specific requirements. These gradations apply equally to syrups from golden syrup down to molasses. The following, list shows the approximate sucrose content of Tate and Lyle refined brown sugars widely used in the confectionery industry:

Grade 10 Pieces	Polarisation 96°.
„ 20 „	„ 95°.
„ 30 T. L. Pieces	„ 92°.
„ 40 Pieces	„ 89°.

Universal Standardisation

It is, perhaps, rather unfortunate that universally accepted terminology or standardisation of different grades of refined sugar has not yet been adopted for world trade. Each refinery has its own particular grading system, so that if a confectioner in South Africa or Brazil desires to use a formula devised in England stating a particular grade of sugar, which may not be procurable in his part of the country, he has no standard to guide him in the adaptation of a similar grade produced by another refiner. Small differences might render formulæ useless, and the adoption of an attitude of "near enough" can lead only to mediocrity. The fact that such standards have never been applied by international sugar refiners is eloquent of the many difficulties to be surmounted. It is, however, a probability that this matter will be discussed in the near future by the authorities concerned. There is no doubt that the establishment of a common set of standards would materially assist better understanding of sugar, wherever its source of production, throughout the confectionery world.

Relative Value Test

A useful method of testing relative values of refined brown sugars is made possible by the Lovibond Tintometer. A 10 per cent. solution of the sugar is prepared and viewed in a 1-in. cell in the tintometer, using series 500 glasses. Taking the above-mentioned Tate and Lyle series of brown sugars as a standard,

Grade 10 gives a reading in the region of	0·5
„ 20 „ „ „ „	1·0
„ 30 „ „ „ „	10·0
„ 40 „ „ „ „	40·0

Sources of Sugar

The chief sources of sugar (sucrose) are the sugar cane and sugar beet. A brief outline of the processes of extraction and refinement of sugar from the cane is consonant with the objective of this treatise, but cannot possibly do justice to the incessant vigilance exercised by the producers and refiners to maintain the highest attainable standard of quality of the product.

Extraction of Sugar from Cane

Sugar cane contains approximately 11-15 per cent. sucrose. The cane is torn and shredded by crushers preparatory to the removal of the juice. The juice is extracted by passing the crushed cane through a series of mills, each of which consists of triple, grooved rolls that exert a heavy pressure on the mass, to which water and weak juices are added to assist maceration and expression. This process extracts 95 per cent. of the sugar-bearing juice from the cane; the resultant bagasse and spent cane is either burned as fuel or used to manufacture insulating material.

Clarification

The expressed juice is screened to remove floating impurities, and treated with lime to coagulate part of the colloidal matter, precipitate some of the impurities and change the *p*H value. Phosphoric acid may be added, since juices which do not contain a small amount of phosphates do not clarify well. If acid is added, an excess of lime is added to maintain a standard *p*H. The mixture is heated by high pressure steam and settled in large tanks called clarifiers. To recover the sugar from the precipitated muds, continuous rotary drum vacuum filters or frame filter presses are used.

Evaporation

The filtrate, a clarified juice of high lime content, contains about 85 per cent. water. It is evaporated to approximately 40 per cent. water in triple- or quadruple-effect evaporators. The resultant dark brown, viscous liquid is concentrated and crystallised in a single-effect vacuum pan.

Crystallisation

The mixture of syrup and crystals, technically called massecuite, is placed in the crystalliser, which is a horizontal agitating tank equipped with cooling coils. Here additional sucrose deposits on the crystals already formed and crystallisation is completed and the massecuite is centrifuged to remove the syrup. The resultant crystals are high-grade raw sugar, and the syrup is re-treated to obtain one or two further sets of crystals. The final liquid, after re-working, is called Black Strap Molasses, which is used for a number of purposes in the confectionery industry, one of which is in the manufacture of licorice.

The light brown raw sugar containing approximately 96 per cent. sucrose is bagged and shipped to the refineries.

Sugar Refining

The refinery is a multi-storied building in which the refining process commences at the top and progresses downwards in order to take full advantage of gravitational transfer of material. The raw sugar (96°) is unloaded from dockside barges into a receiving gallery where the bags are opened, samples of sugar taken for excise and purchasing purposes, and the contents emptied into large storage tanks.

Affination

The raw sugar passes down into a series of horizontal mixing troughs and is mixed to a heavy but fluid mass with cold water and suspended lime solution. This action results in the softening of the coating of impurities, but does not dissolve the sugar crystals, and the lime assists the precipitation of pectins and albumens present. The resultant mass is transferred to batteries of centrifugal machines which remove the syrup, and the remaining sugar is sprayed with water, the discharged syrup being treated separately. Traps are opened in the bases of the centrifuges (Fig. 2), and the sugar dropped into melters to be dissolved in about half its weight of water. Thence the syrup passes to a series of filter presses which yield a clear amber-coloured liquid.

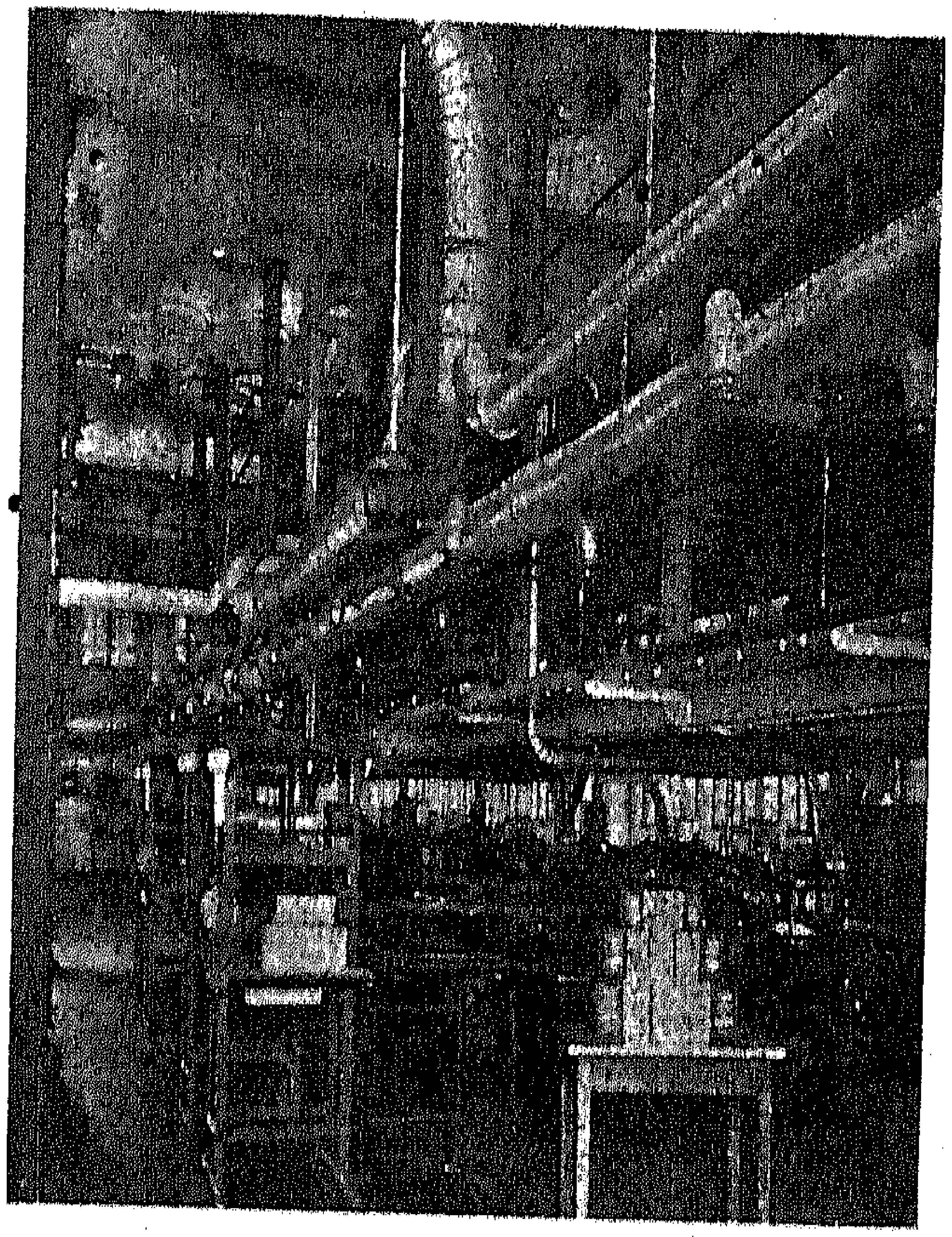


FIG. 1.—SUGAR PACKETING DEPARTMENT.

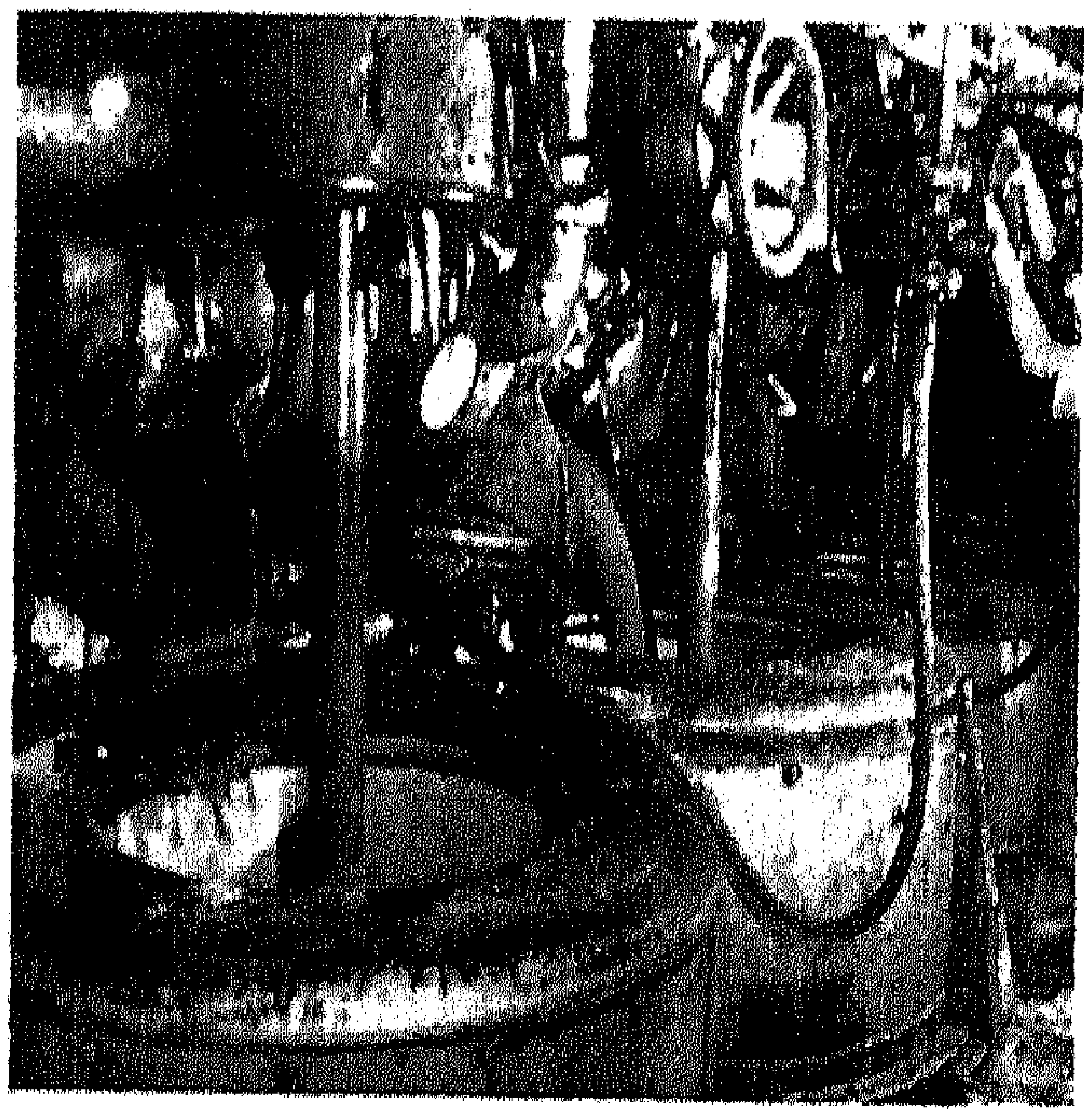


FIG. 2.—CENTRIFUGES IN SUGAR FACTORY.

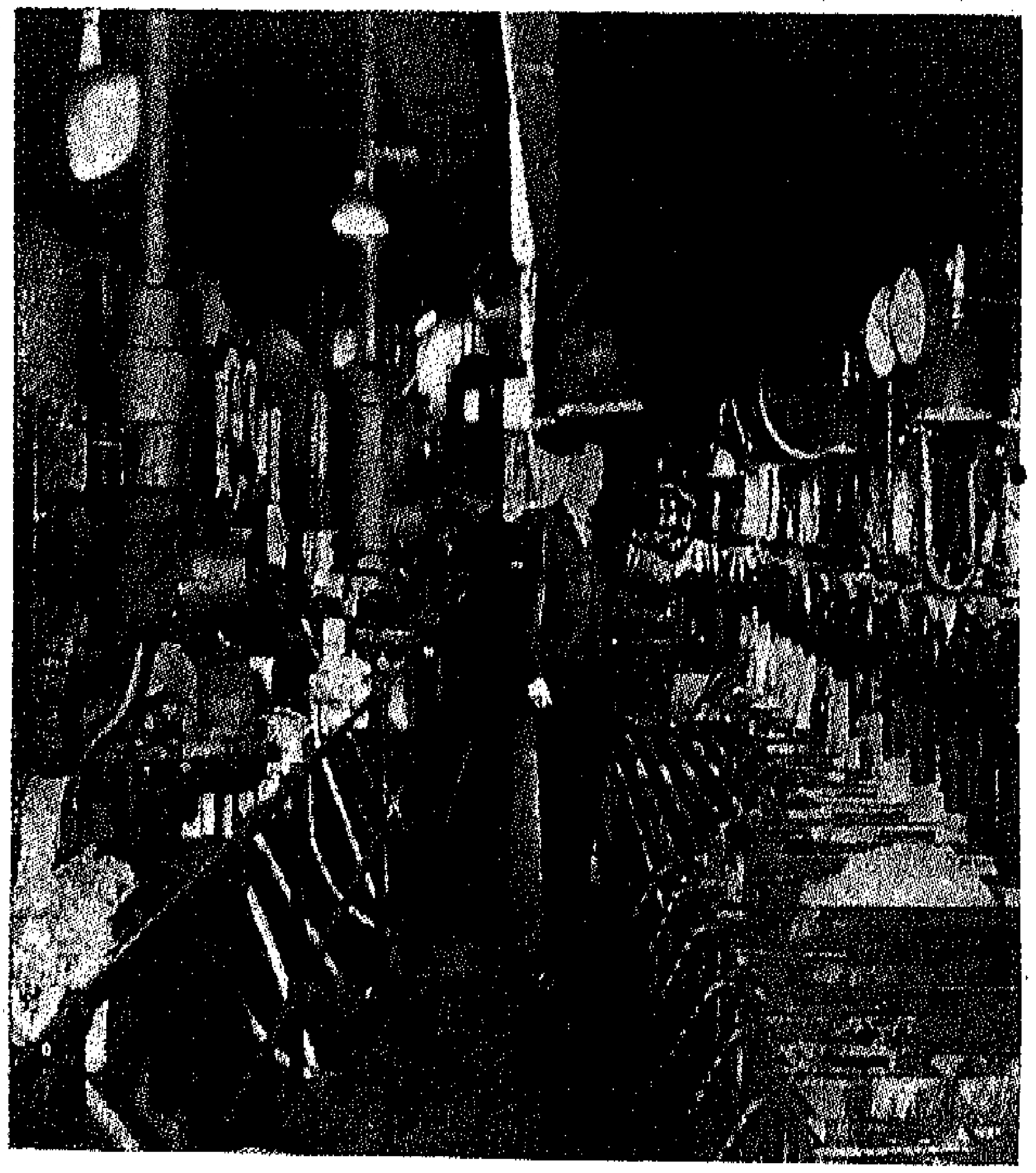


FIG. 3.—LIQUOR ROOM IN SUGAR FACTORY.

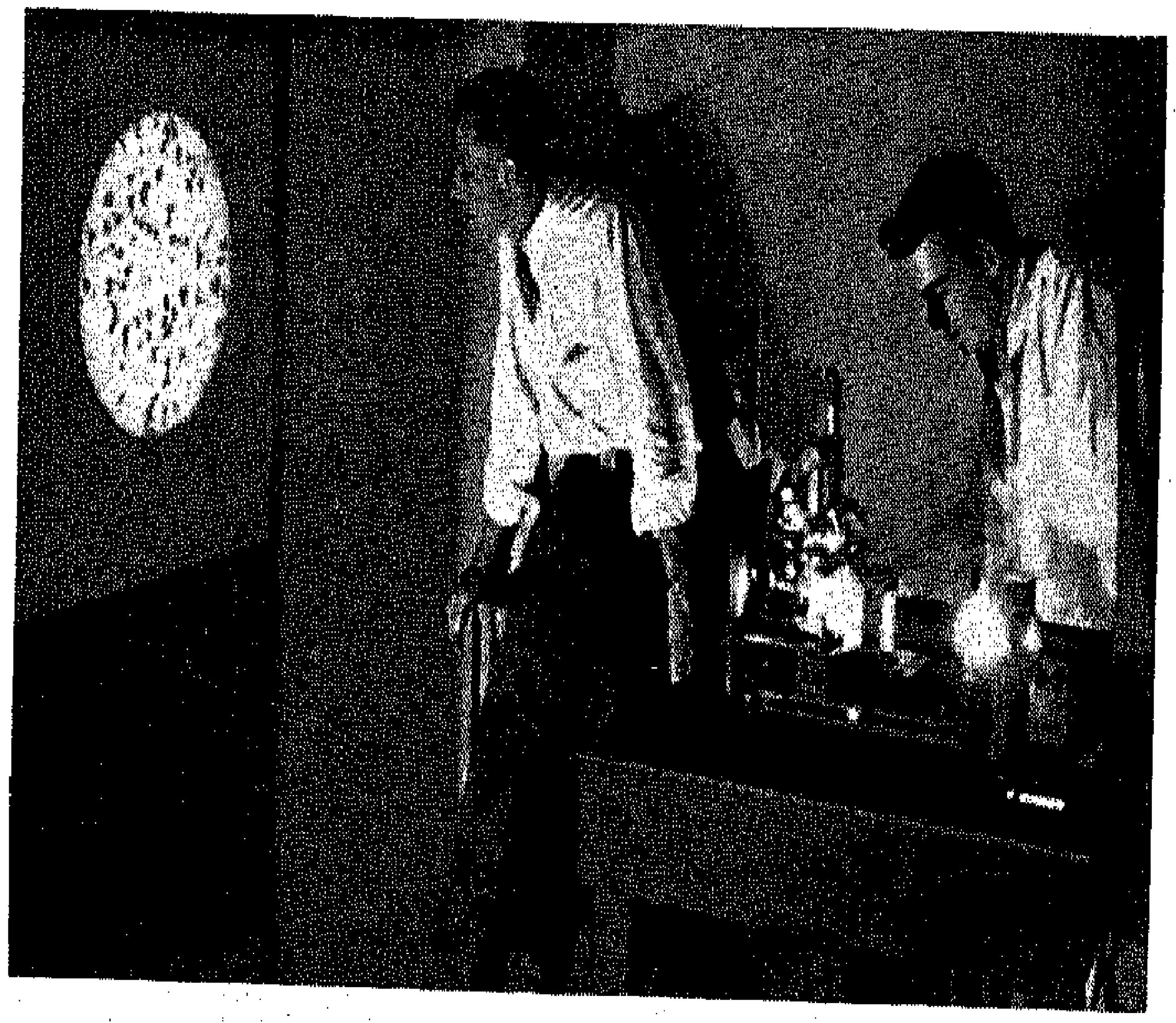


FIG. 4.—TESTING DEGREE OF FINENESS WITH A MICRO-PROJECTOR.

Decolorisation

The filtrate is piped through large elongated cylindrical tanks which are charged with granular animal charcoal. The charcoal decolorises the liquid and absorbs the suspended organic impurities. After a period of about 6 hours' working, the flow of syrup is diverted to another charcoal unit, whilst the saturated carbon in the first tank is reactivated by heating in a kiln at a high temperature. This treatment clears the organic compounds absorbed by the charcoal, which is cooled and returned to circulation (Fig. 3). The now colourless liquid passes into massive vacuum pans of about 2,000 cubic feet capacity, into which a quantity of sugar crystals is injected to promote granulation. The liquid is concentrated until a test shows the exact size crystals required.

The non-sugars in sugar juices have a definite technical importance in the boiling operation, since they control the solubility of sugar in the vacuum pans.

Separation of Crystals

The granular mass, still highly fluid, flows into mixers fitted with beaters to prevent the cooling mass solidifying or forming large colonies of crystals. Thence it passes into centrifuges which separate the crystals from the syrup, which is washed away by high-pressure steam. The washed crystals are transferred to inclined granulators fitted with narrow baffle plates which keep the sugar in constant motion in a current of hot air. The dried sugar passes out of the granulators on to canvas conveyors which carry it to the screening machines over magnetised drums for the extraction of metal. The sieved sugar is conveyed to the automatic packing and weighing machines (Fig. 1). All sugar rejected at each stage is redissolved and reprocessed, and the yield of refined sugar obtained from raw sugar of 96° polarisation is approximately 93-94 per cent.

The extraction of sugar from sugar beet, which contains 13-17 per cent. sugar, entails a considerable number of processes which differ in many respects from those used for cane treatment.

Maple Sugar

Maple sugar is obtained from the sugar maple tree, *Acer saccharum*, which is indigenous to Canada and U.S.A. The juice is caught in buckets suspended beneath incisions made in the bark of the tree, then evaporated so that the sugar crystallises in the supersaturated solution, which is usually poured into moulds. The blocks dry hard, are wrapped, boxed and shipped in this form. The flavour imparted by maple sugar is distinctive and pleasing, and confectionery in which maple sugar has been used is always marketable.

Corn Syrup

Corn syrup was discovered in 1811 by Kirchhoff, whose work on starches gave great impetus to the commercial production of both these materials. Corn syrup (glucose) is an inert and stable monosaccharide, which finds universal use in this industry as the most satisfactory medium for controlling the degree of granulation in sugar confectionery. Corn syrup contains dextrose, maltose, dextrin and water, and its value revolves about the fact that it is a glutinous substance and normally uncrystallisable.

Control of Crystallisation

The control of the tendency of sugar in supersaturated solutions to recrystallise depends on the presence of some invert sugar to coat the sugar crystals in their minute form with a film to prevent a cohesion. This may be done by adding an acid substance such as cream of tartar (potassium acid tartrate), which will chemically change or invert part of the sugar to form non-crystallisable invert sugars and so prevent the re-forming of sugar crystals in a batch of confectionery. This method, however, is very much more difficult and less stable than that in which corn syrup is used, since it is not easy to assess the changes which take place owing to the varying conditions of heating in the factory. Corn syrup is very much more tractable, and therefore is more widely used.

Method of Manufacture

Corn syrup is produced by the hydrolysis of maize starch in the presence of an acid. The starch is hydrolised until it fails to give a starch-iodine reaction. The acids used are either hydrochloric or sulphuric. A starch suspension is pumped into a cylindrical converter and heated to 270°-280°F., over a period of 15-20 minutes. The mixture is adjusted to a *p*H of 4·5-5·5 with soda ash, filtered and concentrated to 30° Baumé. The resultant syrupy liquid is decolorised with animal charcoal and evaporation continued *in vacuo* until concentration has reached 42°-45° Baumé. The final syrup is cooled to the form in which it is used in the manufacture of confectionery.

Dextrose

Dextrose is produced by an extension of the process used for corn syrup. The time of conversion of the suspended, acidified corn starch exceeds that required for corn syrup, since the starch is not only changed to dextrin and maltose, but almost entirely to dextrose. The resultant liquor is neutralised with sodium carbonate, filtered and decolorised with activated carbon. The clear liquid is evaporated, again decolorised, further evaporated and allowed to crystallise to a 99·5-99·9 dextrose equivalent.

Dextrose Hydrate

Dextrose hydrate is a more highly refined form of crystalline dextrose and is obtained by recrystallisation of the latter. Whereas anhydrous dextrose is substantially pure alpha-D-glucose, dextrose hydrate contains a molecule of water of crystallisation. The manufacture of refined dextrose sugars differs from that used for corn syrup production insomuch as a starch suspension of lower density is employed with increased *p*H and higher steam pressure, since the hydrolytic reaction must proceed nearly to completion.

Properties of Dextrose Hydrate

Dextrose hydrate is a white crystalline substance resembling sucrose, possessing 75 per cent. of the sweetness of the latter. It is readily soluble in water at ordinary temperatures, but is less soluble than sucrose. At 86°F., saturated solutions of dextrose and sucrose each contain 54·6 per cent. and 68·1 per cent. sugar solids, but mixtures of the two sugars show higher solubility than would be indicated by the respective solubilities of the two components.

Value in Fondant Manufacture

This property is used in fondant manufacture to retard crystallisation, and thus dextrose hydrate becomes a moisture binder. It is also quickly and completely fermentable, and would provide added invertase with the required amount of fermentable substance to produce a controlled degree of fermentation and aeration in the batch of fondant to render it short eating.

Effect on Boiling Point

Dextrose boils at considerably higher temperatures than sucrose, as shown by the following table:

	Dextrose.	*Sucrose.*
20 per cent. concentration syrup	214·5°F.	213·0°F.
40 ,, ,, ,, ,,	217·0°F.	214·7°F.
60 ,, ,, ,, ,,	222·2°F.	217·4°F.

Thus, if the end-point or degree of concentration is determined by thermometer, the final temperature must be increased when dextrose is present.

Analysis of Commercial Dextrose Hydrate.

Moisture	7·75 per cent.
Dextrose	91·40 ,, ,,
Purity of dextrose solids ..	99·50 ,, ,,
Ash	·05 ,, ,,

Lactose

Lactose (milk sugar) is a constituent of whey, a by-product of cheese preparation. The whey is placed in a coagulating tank and the acidity reduced by the addition of calcium hydrate. The mixture is heated to coagulate the albumen and assist the precipitation of calcium salts. The decanted liquor is transferred to an evaporator and concentrated to 20° Baumé. The resultant syrup is clarified, filtered and subjected to a secondary evaporation, the liquor being allowed to crystallise. The granular liquor is then passed to a mixer to keep the crystals in motion, thence to the centrifugal machines which separate the crystals from the liquor. The crude lactose crystals are finally dried by hot air.

Whey Concentrate

Whilst whey concentrate, which contains approximately 80 per cent. lactose, possesses the property of holding fat in suspension in such products as toffee, it has the disadvantage of imparting a cheese-like flavour to the final product, a flavour which can be counteracted only by adding stronger flavourings such as chocolate liquor, peppermint, etc.

Invert Sugar

Invert sugar is a mixture of glucose and fructose resulting from the hydrolysis of sucrose. It is always prepared by heating a 75-80 per cent. sucrose solution with ·02-·05 per cent. hydrochloric acid or 0·2 per cent. tartaric or citric acid to 203°-212°F. and neutralising with sodium carbonate. The resultant syrup will discolour if concentrated in the usual way. Syrups containing less than 75 per cent. sugar will not crystallise; syrups of 80 per cent. sugar content cool to a solid mass. Invert sugar is lævorotatory, the lævorotation of fructose being greater than the dextrorotation of glucose.

Caramel (Burnt Sugar)

Caramel may be prepared from cane sugar by heating with continual stirring in an iron pan until the whole melts, turns brown, and suddenly froths up. No more than 15 per cent. of the weight of sugar should be expelled, otherwise the product becomes insoluble. Cane sugar caramel is an amorphous reddish-brown brittle mass completely soluble in water. It is usually obtained in concentrated liquid form for ready incorporation in confectionery batches where a rich brown coloration is required.

CHAPTER III

SCIENTIFIC CONTROL

The Importance of Control

A WIDE range of scientific instruments has been evolved to enable the manufacturer to maintain a high degree of quality control in most phases of chocolate and confectionery production, and in the laboratory tests of the raw materials used. Some of these instruments and special apparatus are confined to the laboratory, owing to exact conditions of operation; others are capable of general use in the actual production departments, where rapid tests must be made to avoid a break in continuity. Scientific control of the whole process of manufacture from raw materials to the final study of the shelf-life of the finished and packaged goods is a necessity. Production men in the factory cannot be expected to produce high quality and consistent goods if they are issued with faulty raw materials; they must feel confident that laboratory control is taking adequate care of the incoming material, and they must be equipped with the best possible instruments for testing and control in their own particular spheres.

Temperature, Humidity and Density Control

The part played by the familiar thermometer, hygrometer and hydrometer is well known to all chocolatiers and confectioners. It is necessary, however, to understand that these instruments in everyday use are variable in accuracy under differing conditions of atmospheric pressure and certain material temperatures. They have, therefore, to be checked either daily or periodically to ensure accuracy of readings. In the case of the thermometer, a daily test in water at boiling point is essential to ascertain the adjustment necessary at the prevailing barometric pressure. The reading on a hydrometer varies with the temperature of the solution under test, hence

the importance of remembering to take particular note of the temperature of the solution, especially when making comparative tests. Tables showing the correction factors which have to be taken into consideration are an essential part of such tests.

Viscosity Determination

MacMichael Torsion Viscometer.—The viscosity of chocolate and cocoa solution is determined by means of the MacMichael Torsion Viscometer. This instrument operates on the torsion principle, the viscous drag of a liquid in a rotating cup upon a suspended cylinder immersed in it being balanced against the torsional resistance of the suspension wire. The angular displacement of the ends of the wire are read on a graduated dial.

The cylinder is graduated on its side in 10-millimetre divisions to give depth of immersion. The cup is rotated by means of a two-speed gear box driven by a fractional horse-power motor, the rate of rotation being governed by a rheostat. For chocolate viscosity tests a 26 S.W.G. wire is used, with a 2 cm. diameter cylinder, a 4 cm. immersion, the cup revolving at 20 revolutions per minute, and the temperature maintained at 100°F. for milk chocolate and 130°F. for plain chocolate. The gauge of wire used depends upon the density of the chocolate, a thinner gauge being used for a weaker chocolate. Conversion factors are used to bring all readings to the standard gauge decided upon.

MacMichael Wire Conversion Factors

Wire Gauge.	22	26	27	30	32
22	1·00	5·80	9·50	35·30	—
26	0·17	1·00	1·60	6·10	—
27	0·11	0·61	1·00	4·00	10·00
30	0·03	0·16	0·27	1·00	2·76
32	—	—	0·10	0·36	1·00

Care of Wires

The wires used in the MacMichael instrument should be carefully handled and kept free from kinks. Under stress, wires may become strained. Within the elastic limit, part of the strain is immediately recovered, but part of it may remain as a temporary set on which the wires gradually recover on standing. A rest of 24 hours usually eliminates the set from previous work. Until experience has shown which wire is adaptable for each particular material, it is usually advisable to start with a medium gauge. A table of safe limits and strain points of different gauge wires is supplied with the instrument.

Particle Size Testing

Micro-Projector.—The Baker Micro-Projection Apparatus is widely used to determine particle size of refined chocolate, sugar and other pulverised materials in the low micron or sub-sieve range (Fig. 4). The microscope, which is adjusted to a horizontal position, is worked in conjunction with an epidiascope and a specially prepared screen on which the image of the magnified test sample is projected.

Ocular Micrometer

Fitted to the microscope is an ocular micrometer graduated in squares by means of wires or threads constructed of exceedingly fine cobweb strands. The magnification value of the engraved lines is determined by measuring lines whose distance apart is known on a stage micrometer. In the sample under observation the largest particles are measured, and until these have been reduced to the required fineness in terms of microns, the refining process must continue. As a point of interest, a micron is 1/1000th of a millimetre.

Chocolate Testing

The micro-projection apparatus may be installed either in a small chamber adjacent to the conching machines in the chocolate department or in an easily accessible laboratory. The proximity of the testing equipment to the work-in-progress renders frequent fineness tests a comparatively simple matter.

Determination of pH

The Marconi *p*H Meter is primarily designed for the determination of *p*H of gels and other solutions with a glass-electrode and temperature compensating system, which forms part of the equipment. The control dial is directly calibrated in *p*H units as well as in millivolts.

Method of Testing

When the instrument is set up for making direct *p*H measurements, the temperature compensator supplied with the electrode system is connected and immersed in the solution under test. The function of the compensator is the automatic regulation of the value of the potentiometer e.m.f., so that the true *p*H of the solution at the working temperature is indicated. The temperature compensating system is effective between 10° and 50°C. Operation is comparatively simple, and a high degree of accuracy is obtained provided the instrument is used intelligently.

Buffer Solution

Before testing the particular liquid or semi-liquid sample, the instrument is adjusted to a buffer solution of known *p*H; this solution is prepared beforehand by dissolving a tablet of the buffer salt in 100 ml. of distilled water. The electrodes are placed in this solution, and the instrument potentiometer dial adjusted to zero by operating *p*H dials, which are graduated in direct *p*H readings. The electrodes are withdrawn from the buffer solution, washed with distilled water, and replaced in the solution under test. The needle of the potentiometer is again adjusted to zero by means of the *p*H dials, and the direct *p*H reading taken from those dials. Once the instrument has been adjusted for the buffer solution of known *p*H, it may be used for a continuous series of tests during production.

Determination of Soluble Solids

The Bellingham and Stanley Projection Refractometer (Fig. 5) has been designed for the rapid determination of the soluble solids in various materials under factory conditions. It is eminently suitable for determining the end-point of pectin jelly batches. The refractometer is so constructed that the usual eyepiece is omitted, the figures being read easily on an open scale, for which no magnification is necessary. The material under test is applied to a horizontal prism surface illuminated from below by a small electric lamp. A milled head is operated until the scale is divided into a light and a dark portion. The edge of the shadow indicates the percentage of soluble solids in the material directly on the scale.

The instrument reads from 30 to 90 per cent. soluble solids, and estimations can be made to 0·1 per cent. limits.

Determination of Gelatin Strength

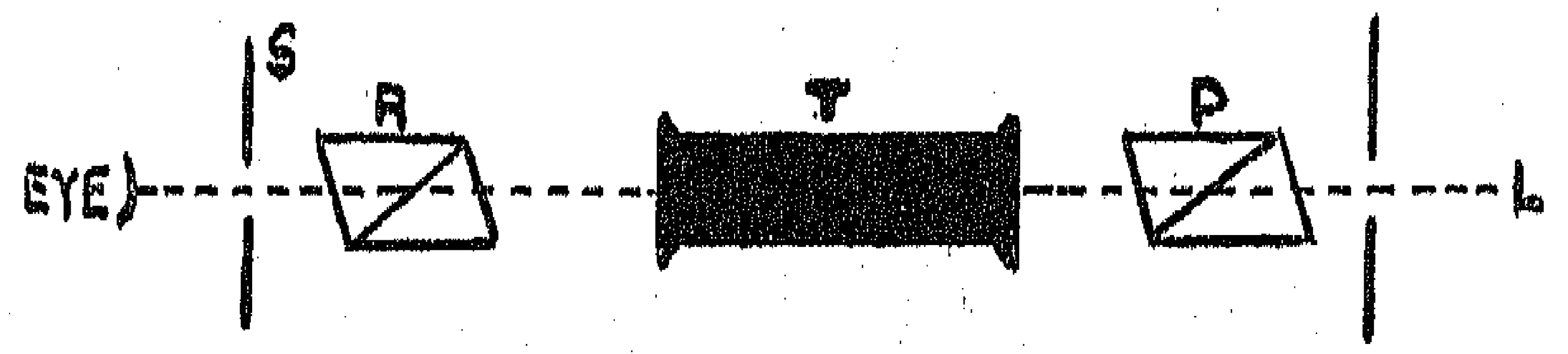
The Bloom Gelometer, for the determination of the gelling strength of gelatin samples, is officially recommended for the establishment of a standard set of values by which the industry may be guided. This instrument gives the weight in grammes required to produce a 4-mm. depression in a gel of 6·66 per cent. concentration by weight prepared at 50°F., the diameter of the plunger being 12·7 mm.

Testing.—The method of sampling the gelatin from bulk, and the complete details of the preparation of the gelatin solution, are given in the British Standards Specification 757:1944. It is essential that the directions stated therein be implicitly adhered to, otherwise any tests made are not comparative with those of the producers of the gelatin and specified strengths cannot be properly checked. The method of sampling is designed to produce samples representative of the total bulk consignment, whether powder or sheet. Having decided by means of empirical tests the grade of gelatin required to produce a particular confection satisfactorily, the manufacturer must establish a standard so that all subsequent batches of that confection are equal in strength and texture.

Working Principle.—The Bloom Gelometer is an ingenious instrument, in which lead shot of special size is caused to flow into a receiving pan placed above the plunger, which rests on the surface of the chilled gel, until a depression of 4 mm. is made by the plunger in that gel. The flow of shot is controlled electrically by means of a 6-volt accumulator connected to the instrument, and is cut off by an electro-magnetic device fitted to the vertical column of the apparatus. The weight of the shot delivered into the receiver, plus the weight of the receiver, is the total weight required to move the plunger through the prescribed distance against the resistance of the gel. This result is expressed as grammes Bloom for a 6·66 per cent. concentration by weight of the sample.

Determination of Sugar Content

The Saccharimeter.—The determination of the strength of a sugar solution is carried out by means of a Saccharimeter, which is a polarimeter (Fig. 6) calibrated directly in percentages of sugar in addition to the normal angular degrees. The term used to denote the strength is "pol" or degree of polarisation. The principle of the polarimeter is based on the fact that sucrose twists a beam of polarised light to the right (dextro-rotatory), whilst invert sugar twists the beam to the left (lævo-rotatory) to a smaller extent. Where pure sucrose gives a right-hand twist of +100, pure invert gives a left-hand twist of − 30.



Arrangement of Parts in a Simple Polarimeter

P is the polariser consisting of a stationary nicol prism, and A is the analyser, a movable nicol prism mounted on a revolving sleeve. The angular rotation of A is measured upon a graduated scale S. L is the source of monochromatic light, which passes through the instrument to the eye of the observer, E. Suppose the nicol A to be crossed with reference to P, the point of light extinction making the zero point on the scale S. If a tube T, filled with a solution of some optically active substance, such as sugar, be placed between P and A, the plain of polarised light emergent from P will be rotated from its original position, and the light will no longer be entirely extinguished in A. By rotating the analyser until its axial plane is perpendicular to the vibrating plane of light emergent from T, the point of extinction is again reached. The angular rotation of the solution in T is then read on the graduated scale.

Polarisation of Sugar Solutions

The polarising power of a sugar is expressed as specific rotation, by which is meant the angular rotation which a calculated 100 per cent. solution, 1 decimetre long, gives to the polarised light.

Equations.—The specific rotation, indicated by the expression $[\alpha]$, can be readily calculated from the angular rotation a of the solution by means of the equation $[\alpha] = \frac{100 \times a}{c \times l}$, in which c is the concentration of the sugar (grammes per 100 c.c. solution) and l the length of the observation tube T in decimetres.

The angular rotation depends on the wavelength of the light employed. Sodium light is generally used for polariscope measurements, and the bright-yellow-line of sodium is designated the D line of the spectrum, and the expression $[\alpha]$ for sodium light is written $[\alpha]_D$. The temperature at which the specific rotation is taken is also usually affixed. Thus, the specific rotation, using sodium light at 20°C., is shown as $[\alpha]^{20}_D$. For example: 20 grammes of sugar dissolved to 100 c.c. gives an angular rotation for sodium light of $+53{\cdot}2°$ in a 4-decimetre tube at 20°C. Thus we obtain:

$$[\alpha]^{20}_D = \frac{100 \times 53{\cdot}2}{20 \times 4} = +66{\cdot}5 \text{ specific rotation of sucrose for}$$

the given concentration.

Conversion of Readings.—To calculate specific rotation from the reading of a saccharimeter, the scale divisions of the latter must first be converted to angular degrees by means of the appropriate factor. For example: 15 grammes of sucrose dissolved to 100 ml. gives a reading of $+57{\cdot}7$ in a 200 mm. tube at 20°C., using a Ventzke scale quartz-wedge saccharimeter. The conversion factor for 1° Ventzke is 0·34657 angular degrees. Thus we have an equation:

$$[\alpha]^{20}_D \text{ sucrose} = \frac{100 \times (0{\cdot}34657 \times 57{\cdot}7)}{15 \times 2} = +66{\cdot}6$$

Determination of Moisture Content

The determination of moisture in boiled sugar goods may be accomplished by weighing a sample of finely powdered sweet and successively washing with anhydrous acetone. As materials other than moisture may be extracted by the acetone, the solvent is distilled or evaporated and the residue weighed. This weight of residue, plus the weight of extracted sweet sample, will give total solids, which, subtracted from the original weight of untreated sample, will give the moisture content.

Spectrophotometry

Although colour, as such, cannot be measured, the visual reaction of the eye of the observer to one colour or tint in relation to another can be ascertained in terms of comparative colorimetric values; this is called spectrophotometry.

Lovibond Tintometer

The simplest instrument used for the colorimetric measurement of sugars for the purpose of matching grades is the Lovibond Tintometer.

Principle of Comparison

The principle of the Lovibond Tintometer depends upon the matching of the colour of a column of the solution under test with the colour of special glass slides when both are simultaneously observed against a white light through an eyepiece. The glass slides bear definite standardised numbers; the darker the tint the higher the number, which figure is given to the particular sample being observed. In the case of soft sugars it is necessary to test solutions of a standard Brix—that is, a standard percentage solution of sugar. Also, as a safeguard against varying degrees of acidity and alkalinity which give rise to lighter and darker colours respectively, it is essential to bring the sugar solution to a standard *p*H when making colorimetric measurements. The glass cells which contain the test solutions are used in varying lengths, according to the colour density of the sample: for dark solutions short cells, and for light solutions longer cells.

There are a number of more elaborate instruments in use, such as the Rosenhain-Shuster, Duboscq, Spengler and Landt and Pfundt Colorimeters, together with several types of spectrophotometers.

Duboscq Colorimeter.—When two solutions of the same coloured material, but of different concentration, are caused to absorb the same amount of light, the concentrations are inversely proportional to the heights of the columns of liquids as observed through the eyepiece of a Duboscq Colorimeter. Thus, if the concentration of one solution is known, and the heights of the two columns of solutions are adjusted to equal intensity, the concentration of the sample solution may be calculated according to the formula:

$$C = \frac{c \times h}{H}$$

where C=concentration of sample.
c=concentration standard solution.
H=height of column sample.
h=height of standard solution.

CHAPTER IV

COLLOIDS

THE chemical and functional properties of the group of substances known as colloids, under which generic heading gelatins, gums, albumens, pectins and starches are collated, are the subject of incessant research relative to their application to the confectionery industry.

Importance of Colloids

So many types of confections owe their characteristic texture to these important colloidal materials that an organised study of the work, past and present, of research chemists would be invaluable to the manufacturer. The evolution of new types of confectionery depends on the extent of our knowledge of the raw materials at our disposal. It is more difficult than ever to create new forms of sweet, since it would appear that the confectioners of the past had already covered an extraordinarily extensive field. To be the first to discover the unknown quantity is the ambition of every manufacturer, and knowledge of the many forms of raw material is the key to success.

Research.—Natural or engineered shortages of materials stimulate research into fresh sources of supply, which in itself is a blessing in disguise. During periods of plentiful supply the practical application of raw material research is not pursued to the extent it deserves. There is a lack of vision, the effects of which every country feels acutely when its natural source of supply suddenly ceases to function.

Fortunately for the confectionery industry, investigations into alternative sources of supply and the possibilities of colloidal material have been intensified, and must inevitably bring to light an application which will result in some new form of confection or assist the industry to solve one of its many problems.

The following brief account of some of the most important colloidal materials used in the confectionery industry is intended to serve as a basis for thought for those manufacturers who may not be fortunate enough to possess a works laboratory and resident chemists. The need to acquire and study specialised publications on the various raw materials used in the industry cannot be too strongly emphasised.

Gum Tragacanth

Source.—Gum tragacanth is obtained from the leguminous plant known as *Astragalus gummifer* by exudation following incision. It usually exudes in thin flakes, and is not merely the dried juice of the plant, but is produced by the metamorphosis of the cell membrane. The better grades of gum are collected during the months of May, June and July.

Properties.—Gum tragacanth, which absorbs approximately fifty times its own weight of water, consists of a water-soluble fraction, tragacanthin, and a water-insoluble fraction, bassorin. These two components may be separated by filtration of dilute mucilage, and the tragacanthin content determined by evaporation of the filtrate. The value of a gum sample is in inverse ratio to its tragacanthin content. It has been proved that gums with a high methoxyl content produce mucilages of the highest viscosity, and, as the tragacanthin fraction contains no methoxyl groups, whereas bassorin contains 5·38 per cent. methoxyl, the above method of analysis will determine the efficacy of the gum.

Precautions.—Heating of the dry gum produces demethylation with a consequent loss of viscosity, therefore great care has to be exercised in the grinding of gum owing to the amount of heat generated. When soaked in water preparatory to use in confectionery, the resultant mucilage must be passed through a fine-mesh sieve to free it from extraneous matter and lumps. As prolonged storage and moisture have a deleterious effect on gum tragacanth, the gum should be bought in reasonable quantities, and stored in warm, dry conditions.

Gum Arabic

Source.—Whilst the chief source of gum arabic is the Sudan, the gum-bearing acacia, from which it is extracted, grows widely throughout Africa, India and Australia. The best

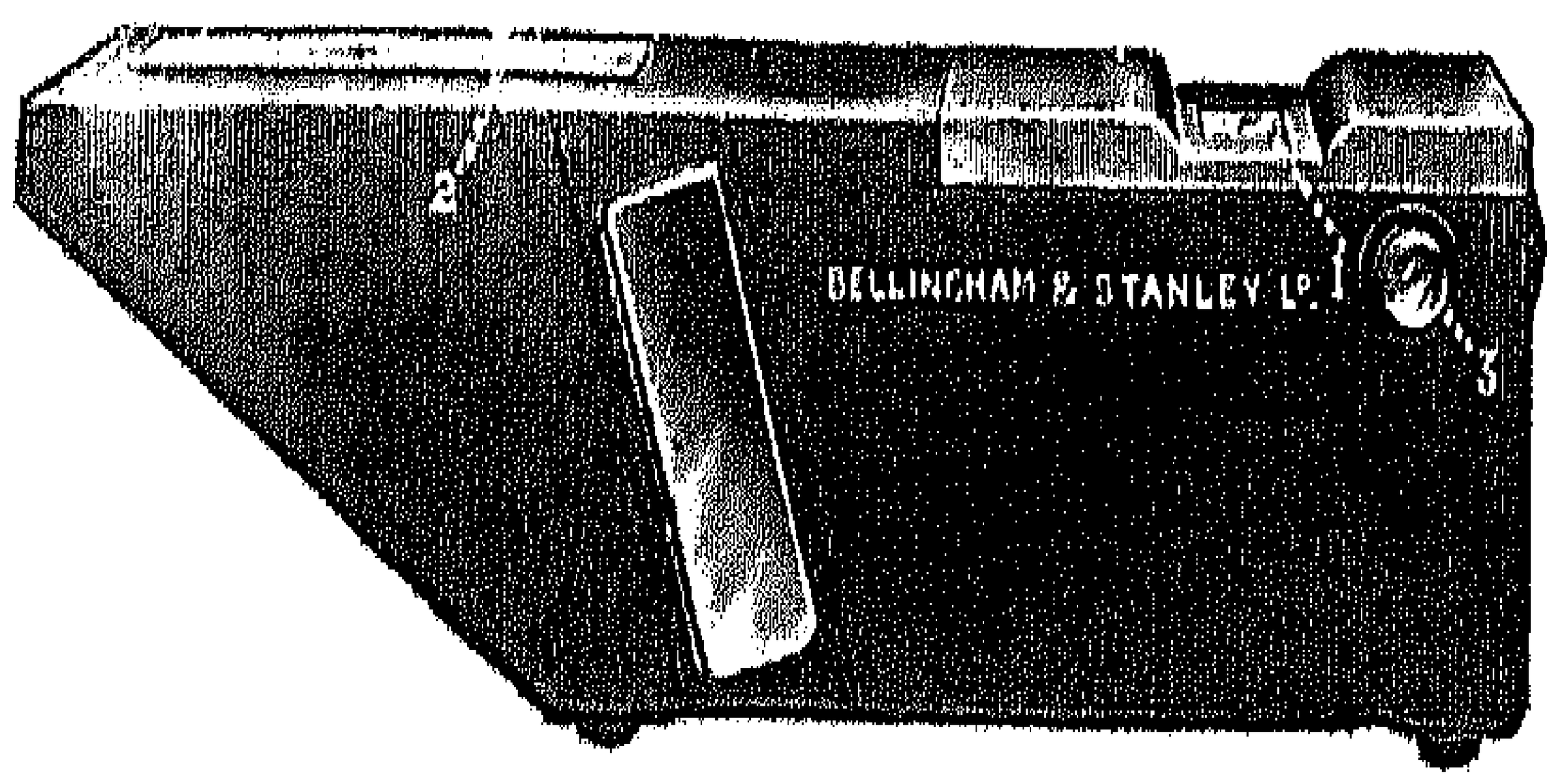


Fig. 5. B.-S: Projection Refractometer.

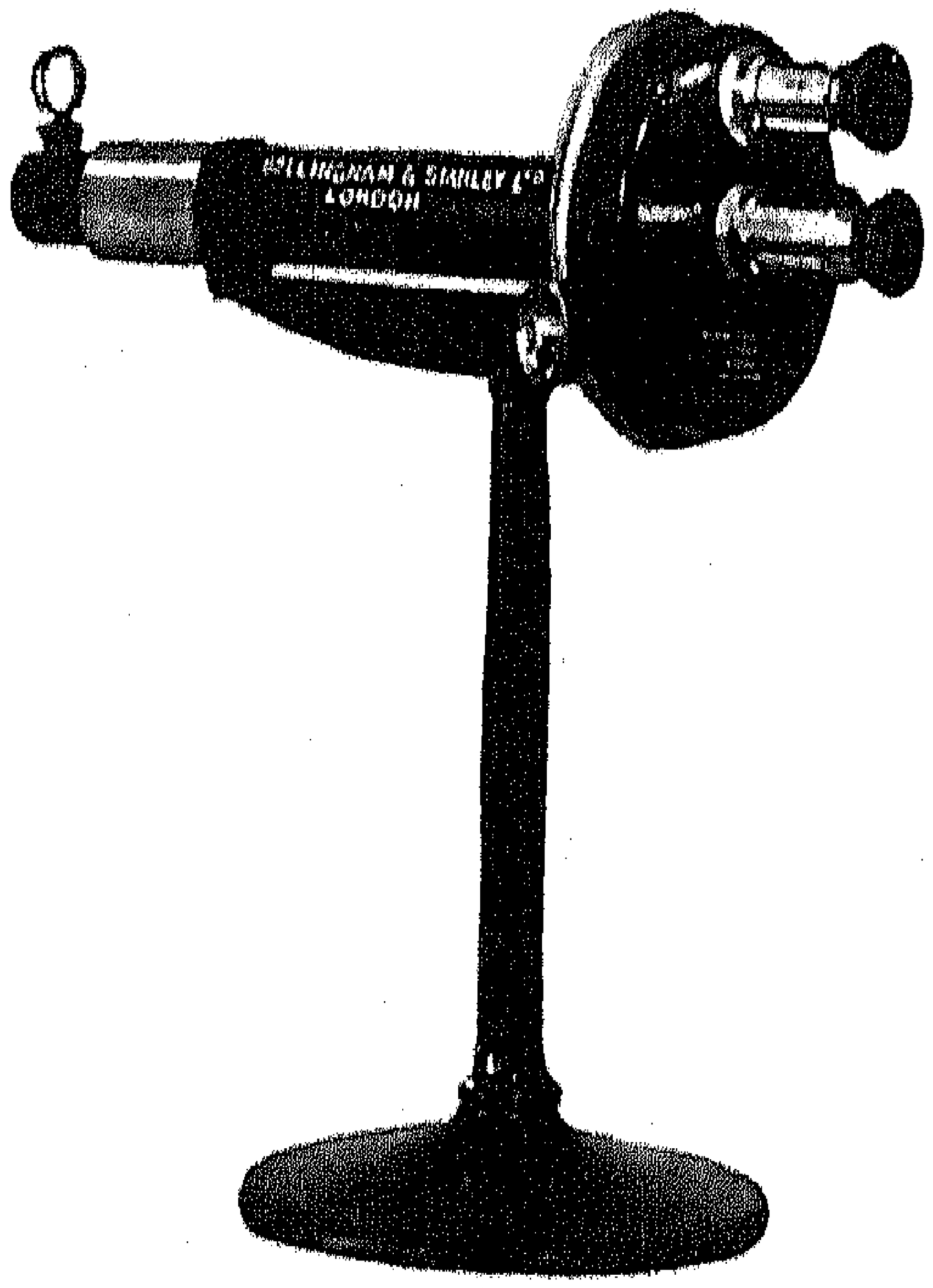


Fig. 6. B.-S: Polarimeter.

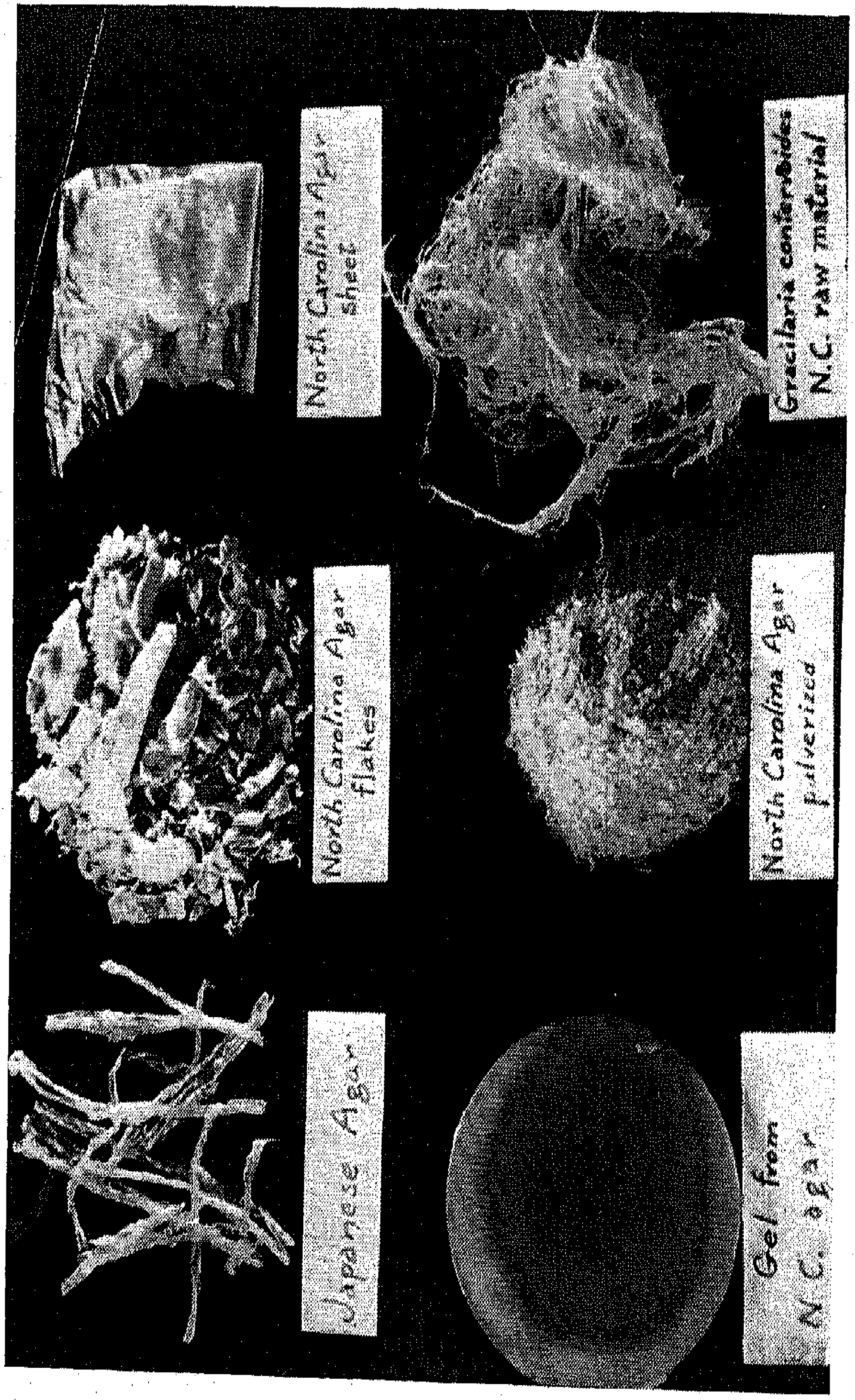

North Carolina Agar sheet
Gracilaria confervoides N.C. raw material
North Carolina Agar flakes
North Carolina Agar pulverized
Japanese Agar
Gel from N.C. agar

FIG. 7.—SPECIMENS OF AGAR.

variety is the Kordofan, but Senegal and Mogador gums are also of excellent quality.

Collection.—The gum is obtained by incision of the stem and branches of the tree and collection of the exudation. The gum exists in small tears and lumps varying from small drops to the size of a walnut. It is an interesting fact that unhealthy trees produce a greater yield than those in a healthy condition. Samples of gum should be examined for extraneous matter, such as bark, stones and fibre, when purchasing. It is essential to filter gum solutions before use to remove impurities and any undissolved pieces, otherwise these will become unpleasantly hard in the final product. Gums are used to produce slowly soluble hard gums and high-grade lozenges.

Gum Chicle

Source.—Gum chicle is the sap of the *Achras sapota*, an evergreen tree indigenous to South America, the West Indies and Mexico. The sap is obtained by exudation from herringbone incisions made in the bark of the tree. The liquid is partially evaporated until it contains about one-third of its weight of water, filtered and cooled in moulds.

Properties.—Its application to chewing gum products depends on its complete insolubility in water and its latex-like plasticity. So far, no adequate substitute has been found to take the place of chicle gum, which is expensive, but several natural products will act in satisfactory combination with chicle.

Substitutes.—Such fillers are inferior grade guttas; some derivatives of Borneo jelutong; waxes, such as beeswax and spermaceti; resins and balsams. Appropriate substitutes or combinations of substitutes may be used in equal proportion to the chicle gum without too seriously affecting the final product. Before use in the production of chewing gum, the chicle is broken into small pieces, melted and passed through a fine sieve to remove foreign matter and lumps.

Gelatin

Source.—Gelatin is an organic nitrogenous colloidal protein, whose important value in confectionery is its gelling and emulsifying properties. It is obtained by a process of hydrolysis weight of water. Add this solution to a mixture of equal proportions of corn syrup and invert sugar, so that the albumen ratio will be 1 or 2 per cent. of the total weight. Beat each sample mixture under equal conditions and determine the weight of 1 gallon of the resultant frappé at intervals of 5, 10 and 15 minutes. The volume at each period gives a definite weight. The sample showing the lowest weight and the longest retention of body is the most satisfactory. Since albumen is highly susceptible to bacterial infection, it should be stored in hermetically sealed containers and all albumen solutions treated in non-corrosive vessels.

Soy Albumen

Source.—Soy albumen is a highly refined protein derived from the soya bean and possesses exceptional characteristic and functional properties. It is a white powder, readily soluble in water, and therefore requires no soaking before use. It can be whipped up rapidly to a large volume of small, uniform air cells which produce an extremely smooth creamy mass. Soy albumen proteins, unlike their egg counterparts, do not coagulate on subjection to heat, and as a result, this albumen produces a short, tender texture in the final product.

Method of Using.—Hitherto it has been generally considered essential to use egg albumen for its heat-coagulating properties, to produce sufficient stability to retain the air cells in the final product. Whilst this is an advantage in certain types of confectionery, comparable results can be obtained by controlling the total moisture in the batch. The chief function of an aerating agent is to incorporate air in a finely divided state into the batch, so that the finished product will be large in volume in relation to its weight. Soy albumen attains a much greater volume, when beaten, than egg albumen, and also requires less water. Optimum stability is obtained with a proportion of 2 lb. of soy albumen in 4 lb. of water to 100 lb. of syrup, which must be cooked sufficiently to ensure that the total moisture in the final batch does not exceed 18 per cent.

Flours

A considerable amount of research has been undertaken to produce satisfactory flours from peanuts and soya beans for use

in confectionery production. The oil is first extracted from the peanuts by hydraulic press and, in the case of soya beans, by a combination of steam treatment and solvent extraction, the final flour being obtained by air separation.

Soya Bean Flour.—The chief objection to soya bean flour has been its strong, unpleasant flavour, and most of the methods used to eliminate this flavour involve some form of heat treatment. The value of flours lies in their high protein content, although large quantities are not generally used in the confectionery industry owing to the fact that confectionery containing flour is rough to the palate and the flavour of flour too easily detected.

Wheat Flour

Wheat flour consists principally of 70 per cent. carbohydrates, mainly in the form of starch, proteins 9½-11 per cent., and moisture 12-15 per cent. Wheat flour is used in licorice paste manufacture chiefly because the major proportion of protein is represented by gliadin and glutenin, which have the property of forming with water a colloidal complex possessing certain elastic properties.

Corn Flour

Corn flour or starch is by far the most important of the flours used in the industry. It is the cheapest and most satisfactory medium for the moulding of creams, jellies and gums, and a modification of corn starch is the basis of Turkish Delight and starch gum products. It is the raw material from which corn syrup and dextrose hydrate are produced, not to mention dextrins and gums which find so wide an application in packaging and labelling.

Grades.—Various grades of corn starch are marketed, Crystal, Pearl, Common and Special Powdered. Corn starch which has been further processed for use in confectionery is called Thin Boiling Starch: a highly oxidised form of starch. If ordinary corn starch is used in the manufacture of hard starch gums, retrogradation or breaking down takes place on storage of the final product, which becomes very cloudy.

Modified Corn Starch.—When corn starch is subjected to acid treatment, the hot paste viscosity of the starch is reduced, but the resultant modifications of fluidity grade 40 and 60 produce pastes of increased gelling power as compared with untreated starch. Fluidity in a hot paste facilitates the casting of starch goods in mould impressions, and the prevention of tailings during casting depends on the method employed to modify the corn starch to the thin boiling variety. The relative increase in the gelling power of starch modifications is subject to several variable factors employed during conversion. Normally, the conversion of the starch is carried out in suspension with 0·1 N sulphuric acid at 125°F. for 10-15 hours.

Effect of pH.—As the *p*H of the suspension is reduced and the time of conversion is increased, thin boiling starches are produced of fluidity 60, which cook to rather soft setting pastes. As the *p*H is increased and the conversion time reduced, a thin boiling starch of increased gelling strength is produced.

Fluidity Values.—Clarity of the confectionery starch gum is a desirable feature in such products, and relatively clear gums may be produced from thin boiling starch of a higher fluidity than 60. There is, however, a tendency to loss of gel strength, and the resultant goods are somewhat softer than may be desired. It is possible to produce a thin boiling starch of high gelling strength and an extremely clear hot paste by oxidation of corn starch with calcium peroxide, a process covered by U.S. Patent 2,268,215. During gelatinisation, thin boiling starch granules swell considerably less than those of untreated starch, and are inclined to disintegrate into small particles, which accounts for the reduction in viscosity. The fluidity values are, of course, measured by means of suitable viscosimeters. It is advisable to bear in mind that the fluidity of a thin boiling starch plays an important part in the successful production of hard starch gums, starch jellies and Turkish Delight. In the case of hard gums the fluidity of the modified starch should be 40, for starch jellies 60 and 65, and Turkish Delight 65.

Potato Starch

Although potato starch is sometimes loosely described as farina, since they are derived from the same source, there is

a difference between the two forms. Potato starch contains the fibre of the tubers, whilst farina is free of all fibrous material. In spite of the fact that farina possesses no gluten, and is therefore weaker in binding power than wheat or corn starches, it is used in confectionery as a filler because it is a soft starch possessing a high moisture absorption power. It should be used sparingly and generally only in the cheaper classes of confectionery, where its special properties will serve a definite purpose.

Storage.—As the critical moisture content for fungal growth in flour is 15-16 per cent., wheat flour and farina should be stored in a dry atmosphere of less than 80 per cent. relative humidity, preferably in galvanised steel bins, which have the advantage of protecting the flours from rodents.

A number of modified starches are now produced so that their dried finished state on subsequent dispersion as a gel or paste will form products of varied physical characteristics. The alkali or *p*H adjusted starches yield thick-bodied starches, whereas those treated with dilute acids below the bursting or pasting point of the granule yield thin-bodied or low viscosity starches.

CHAPTER V

RAW MATERIALS

Essential Oils and Essences

Flavourings constitute a very wide field, from essential oils, which are obtained by simple expression from oil-bearing fruits, to synthetic essences, which are composed of aromatic organic compounds. In the case of essences, whether fruit or synthetic, the constituent oils or aromatic compounds are brought into a perfect solution by means of a suitable solvent, such as isopropyl alcohol. Another type of flavouring essence may be composed by using an extract of a fruit and reinforcing the natural products with suitable added synthetics. A typical formula is given here:

Apricot extract	1,000 parts
Gamma lactone of undecylenic acid ..	10 ,,
Nonyl aldehyde	1 part
Vanillin	0·5 ,,
Ethyl vanillin	0·2 ,,
Ethyl cinnamate	0·2 ,,
Benzyl cinnamate..	0·2 ,,
Tannic acid	0·1 ,,

Peppermint Oils

Source.—Peppermint oil is distilled from the perennial herb *Mentha piperita*, which grows in the temperate climate of the U.S.A., Europe and Asia. The so-called Japanese peppermint is derived from the herb *Mentha arvensis*, grown extensively in Japan, Brazil and California. The oil is less fragrant than the piperita variety and possesses a peculiar bitter taste, possibly because of its higher menthol content. It is extracted by steam distillation. Another popular flavour is spearmint, derived from the herb *Mentha viridis*, grown chiefly in Michigan, U.S.A. It would be a step in the right direction if this plant were more widely cultivated, as the flavour is interesting, pleasing and produces a cooling sensation on the palate. Owing to their high volatility, peppermint oils should be stored in a uniformly cool room and the containers kept well sealed.

Floral Attars

Source.—Floral ottos or attars are obtained by distillation or solvent extraction of the attar content of leaves, flowers, gums or woods of plant life. When it is considered that 1 lb. of rose attar requires 20,000 lb. of rose petals for its production, one can readily understand why these attars must be compounded with less expensive aromatic products before use in confectionery. The chief source of attar of rose is Bulgaria, where it is steam distilled from the petals of the damask rose. A drawback in the steam distillation process is that the sweetest constituent, phenylethyl alcohol, is carried away in the distillation water, and results in an attar whose odour is quite different from that of the natural rose. The usual adulterant for this attar is geraniol or synthetic rose. Musk, which forms the basis of a popular cachou flavour, is derived from glands of the male musk deer of Tibet.

Synthetic Attars.—Most of the floral attars are now produced synthetically, which brings the price within the compass of the confectionery manufacturer, particularly as only very small amounts are required to flavour a batch of lozenges or cachous adequately.

Citrus Oils

The discriminating manufacturer exercises a considerable amount of caution when buying a citrus oil, since it is possible to adulterate the natural oil with terpenes and lemongrass citral without deviating from the requirements of the legislated standards. The development of the machine pressing of citrus oils has not improved the quality of these oils.

Lemon Oil.—For example, the finest lemon oil is produced by manual sponge pressing. It may seem strange in this machine age that a manual operation should take precedence over a mechanical method, but hand pressing is the most scientific means yet devised by man for the production of perfect lemon oil. It is unspoiled by heat, steam, oxidation or metallic contact, and possesses all the characteristics of the pure, natural oil. If a confectioner requires the best possible lemon oil, he demands sponge-pressed oil. A useful point to remember is that the addition of small amounts of lemon essence will enhance the flavours of other fruit essences such as Blackcurrant and Raspberry.

Vanillin

Source.—Vanilla or Vanillin, which was known to ancient civilisations in South America, is obtained from the seed of the vanilla plant grown in Mexico, Brazil and Madagascar. The green beans are cured immediately after a sweating process to prevent spoilage. During the curing the glucoside content is changed to vanillin, which crystallises on the surface of the beans.

Synthetic Vanillin.—Vanillin is also produced on a large scale from eugenol derived from clove oil, and this is the form in which it is most widely used. A comparatively new source of this valuable flavour is lignin, which holds great possibilities of development. Vanillin, which is a crystalline substance, may be added to batches of confectionery and chocolate in its original form or in solution; owing to its high volatility it should be added as near to the end-point of cooking as possible.

Coumarin

Source.—Coumarin, another crystalline flavour, occurs widely in plant life, and is usually extracted from the tonka bean by alcohol solvent. There are also a number of processes by which coumarin may be produced synthetically. It is a flavour to be used cautiously in confectionery, since it is strong and has a peculiar aromatic reaction to the palate if overdone. In small quantities and in conjunction with vanillin it can be quite pleasing, particularly in caramels and cocoa powder. Both coumarin and vanillin must be stored in well-sealed containers in cool conditions to prevent loss through evaporation.

Fruit Juices

Methods of Extraction.—In certain types of confectionery the flavour is enhanced by the inclusion of concentrated fruit juices. Citrus fruit juices are extracted from the fruits by reaming the flesh from the rind so that the oil is not removed at the same time. Berry juices are obtained by hydraulic expression.

Preservatives.—The juices must, naturally, be subjected to some form of preservation to prevent the growth of micro-organisms and ultimate spoilage, and the usual method is the addition of sulphurous acid, which is SO_2 in solution with water. The amount necessary to prevent spoilage varies from ·02 to 0·1 per cent. in terms of SO_2. Most of the preservative is eliminated during the boiling process. The concentration of fruit juices is carried out under a partial vacuum at a temperature not exceeding 150°F.; higher temperatures cause deleterious flavour changes. A more satisfactory but expensive method of concentration is by freezing the juice and removing the necessary amount of ice slush by centrifuge.

Storage.—The optimum temperature for satisfactory storage is 60°F., and the containers should be closely sealed against infection and loss of SO_2.

Concentrated Fruit Juices.—From a scientific point of view concentrated fruit juices are more satisfactory than those of natural strength, since they do not require the addition of SO_2 as a means of preservation. SO_2 has the property of combining with aldehydes and ketones, to which fruit partially owes its flavour. Fruit concentrates, on the other hand, possess a high acidity which greatly improves their keeping quality. Concentrates are given one sterilisation and this is sufficient to keep them for prolonged periods without deterioration. In the preparation of a good quality fruit concentrate the extractive matter from the skin or marc of the fruit is concentrated together with the fruit juice, and therefore possesses greater flavour power than a concentrate of fruit juice alone.

Borneo Tallow

Source.—Borneo tallow is the generic term applied to the fats obtained from the kernels of a number of closely allied trees of the genera Shorea and Isoptera, which are indigenous to the Suda Islands, Malaya and Indo-China. The dried kernels constitute the so-called illipé nuts of commerce, and contain 43-61 per cent. fat. Borneo tallow is a hard, non-greasy fat of a pale green colour and has a melting point of 82·2°-100·2°F. It closely resembles cacao butter in physical properties. In particular, it displays a similar combination of a low melting point with a characteristic brittle consistency, which renders it a valuable substitute for cacao butter. The snap is a consequence of these species of fats possessing a simple glyceridic composition, and high content of the mixed glyceride oleo-palmito-stearin.

With the exception of cacao butter, fats used in confectionery manufacture are subjected to a process of hydrogenation which raises their melting points.

Coconut Oil

Coconut oil, which at ordinary temperatures is solid but becomes liquid at summer temperatures, is used in its normal state for certain types of confectionery because of its characteristic coconut flavour. The oil itself is unstable and becomes rancid after a comparatively short period, a process that is retarded by the addition of various antioxidants.

Hydrogenation.—The process of hydrogenation (Fig. 8), which converts liquid oils into solid fats, is accomplished by dissolving the oil in alcohol or by simply melting and heating in a pressure vessel to 250°C. in the presence of a catalyst and hydrogen. This has the effect of strengthening the carbon atoms and increasing their resistance to heat, which has the power of their dissociation. As in the case of most oils, coconut oil loses most of its odour and flavour during hydrogenation.

Such oils as palm kernel, groundnut and cottonseed are hydrogenated to produce solid fats of a range of 89°-93°F. and 96°-100°F., which find application in chocolate on which they have a bloom-inhibitive influence.

This applies chiefly to the hydrogenated fats from groundnut or peanut and cottonseed oils. These fats with a melting point in the neighbourhood of 95°F. possess a greater degree of contraction on cooling to 50°F., which property closely approximates that of cacao butter. The addition of hydrogenated fats to chocolate requires careful process control, as the number of fats of varying melting points already present in the cacao butter is thereby increased.

Confectionery Fats.—A range of confectionery fats can be obtained at melting points varying from 88° to 120°F. The higher the melting point of the fat the greater the degree of masticity of the confection in which it is used. Certain types of chewing sweets rely on a high melting point fat to give them this particular quality. The fats used for this purpose are usually prepared by spraying into a refrigerated chamber, the fat flakes being packed loosely. The fat is incorporated into the batch on the cooling slab before the batch is aerated on the pulling machine.

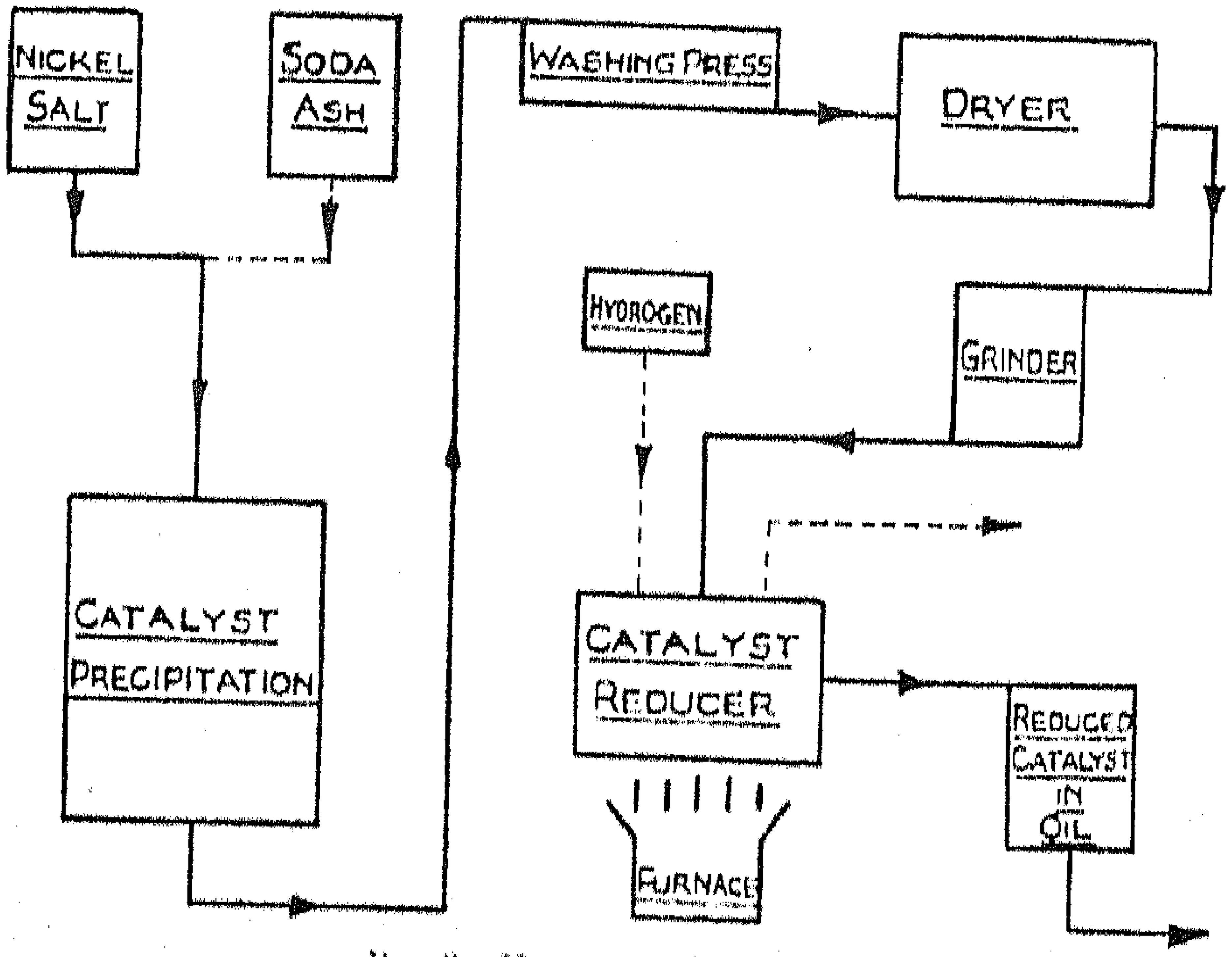


FIG. 8.—HYDROGENATION PLANT.

Synthetic Fats.—Synthetic fats are produced by the esterification of glycerol with fatty acids prepared by the oxidation of hydrocarbons—*i.e.*, coal-tar products. A considerable amount of research work is still needed to overcome the many objections to the resultant products of such syntheses, but fats will almost certainly be produced and perfected which will have application in the confectionery industry.

Citric Acid

Source.—Citric acid is produced by the action of *Aspergillus niger* mould on sugars, or processed from cull lemons which are sound and free from mould. In the latter case the juice is expressed from the fresh fruit, which has been previously macerated to facilitate pressing, and the resultant liquid contains about 4 per cent. citric acid. As the fresh juice is difficult to filter, owing to the presence of pectins and gums, it is fermented to break down the latter. Although very little citric acid is lost during the actual fermentation process, film yeasts grow on prolonged standing and cause a rapid loss in acid.

Preparation.—The fermented juice is mixed with a little infusorial earth and boiled. The earth is added to promote quick sedimentation. The hot liquor is filtered, and the filtrate treated with hydrated lime sufficient to neutralise approximately 90 per cent. of the total acidity of the juice. The remaining 10 per cent. acid is neutralised with calcium carbonate. If the neutralisation process were carried out by means of hydrated lime alone, pectic substances and gums would be precipitated, the colour darkened and the colour of the final crystals affected. The next stage is the recovery of the insoluble calcium citrate formed, and as this citrate is more insoluble at high temperatures, the filtration is carried out at the highest possible temperature.

Sulphuric acid 66° Baumé is mixed with the citrate to recover the citric acid, which is filtered off from the insoluble calcium sulphate formed. The citric acid solution is concentrated to 39° Baumé and allowed to crystallise.

Purification.—The crude crystals are redissolved and all metallic and other impurities removed by various methods to render the citric acid suitable for use in the food industry.

Tartaric Acid

Source.—Tartaric acid occurs as crude acid potassium salt in argols and wine lees, the solid deposits left in a wine vat after fermentation. The pure acid potassium tartrate is obtained by leaching with water, precipitating calcium and other impurities, evaporation and crystallisation. Tartaric acid in argols varies from 40 to 70 per cent.

Preparation.—The argol is mixed with water, hydrochloric acid at 20° Baumé is added and the mixture boiled. The solution is partially neutralised with milk of lime, calcium tartrate being precipitated, whilst potassium tartrate and calcium chloride remain in solution. The potassium tartrate is decomposed by boiling or by adding calcium chloride solution. A small proportion of the potassium tartrate is left in solution to prevent the precipitation of iron salts and alumina.

The calcium tartrate is mixed with water and decomposed with sulphuric acid. Finally, the liquid is filtered and the tartaric acid filtrate concentrated *in vacuo* and crystallised. Tartaric acid is less hygroscopic than citric acid, a property which is utilised in the preparation of lemonade powders and crystals.

Glacé Cherries

Glacé or drained cherries are often produced collaterally in the confectionery factory, since they constitute a useful and profitable side-line for distribution to the bakery-confectionery trade. The following outline of the process will assist those who are interested in this particular product.

Preparation.—Bleached cherries are received into the factory packed in barrels and preserved in calcium bisulphite. The fruit is drained from the liquor, pitted and washed with running water for at least 24 hours to remove most of the SO_2. It is transferred to a large wooden vat fitted with a steam coil, with sufficient water to cover and allow for free movement, a perforated wooden disc being placed on the surface to keep the cherries under the level of the water. The fruit is boiled in several changes of water until it is tender, the time varying with the texture of the cherries, from 1 to 4 hours. The surface is repeatedly skimmed to prevent impurities discolouring the fruit. The liquor is then cooled slowly by adding cold water, and the fruit left to stand for 24 hours to leach out the remainder of the SO_2.

Colouring.—The now tender cherries are drained, transferred to wooden vats fitted with drain cocks in quantities of 112-224 lb. (51-102 kilos), and covered with cold sugar syrup at 20° Baumé containing ·02 to ·05 per cent. erythrosine or Ponceau

3R, according to the shade required. Alternatively, a mixture of the two dyes may be used. Erythrosine results in a strong pink colour with a bluish tinge, and Ponceau 3R in a richer red.

Syruping.—The cherries are allowed to stand in this syrup for 24 hours, then drained. The syrup is drained off, boiled, skimmed and sufficient sugar-corn syrup solution, made up of equal proportions of each raw material, added to increase the density of the syrup 2° Baumé. The addition of the corn syrup prevents the overdrying and increases the final transparency of the fruit. The process is repeated on alternate days until the syrup contains 75 per cent. soluble solids, when tested by refractometer. On the last day the cherries may be boiled in the syrup, allowed to stand for 48 hours, and finally drained on sieves for not less than 24 hours.

Grading.—They are then sorted into three grades: perfect cherry; badly split, discoloured and misshapes; and debris cherries. The drained cherries should show an increase of 10 per cent. in weight.

Continuous Process.—In the Navarre continuous syruping plant syrup passes over the cherries continuously, the syrup being boiled *in vacuo*.

Nuts

Nuts, which constitute such an essential raw material for the confectionery industry, are an exceedingly valuable food. Their source of origin is varied: walnuts, France; almonds, Italy; hazelnuts, Spain; coconuts, the tropical countries; brazil nuts, Brazil; pecans, North America; and cashew nuts, India.

Coconut

Source.—The coconut, whose oil has been used as a food from ancient times, is the only nut requiring mechanical processing before it can be used in manufacture. The bulk of the world's supply of copra and coconut oil is derived from the fruit of the species *Cocos nucifera*, or coconut palm, which grows on the coasts of all tropical countries, and is extensively cultivated in the Malay Archipelago, India and Ceylon. When fully ripe the nuts contain only a small amount of milk, the bulk having coagulated to form the thick, fleshy endosperm, coconut meat.

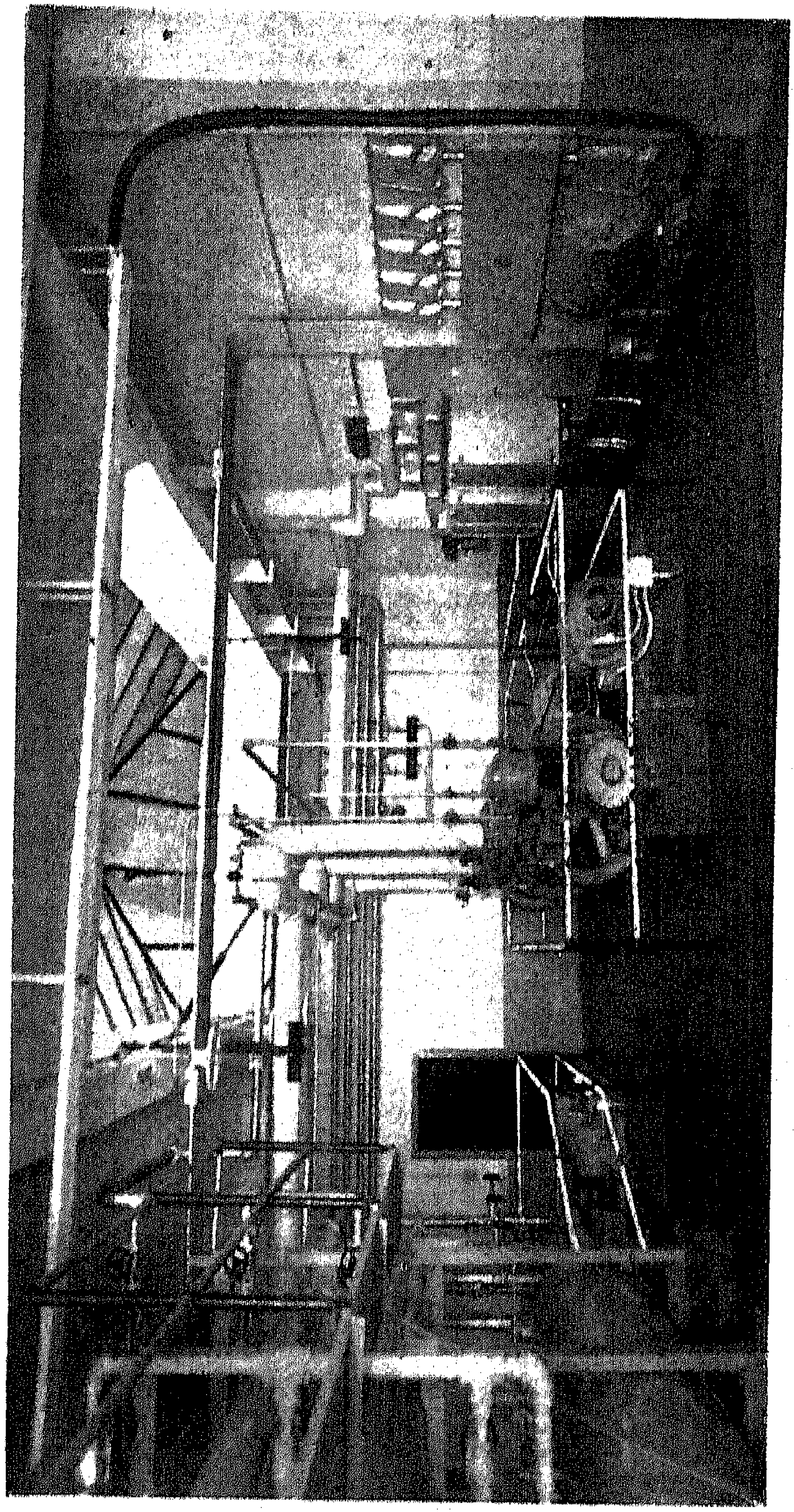


Fig. 9.—Refrigeration Plant.

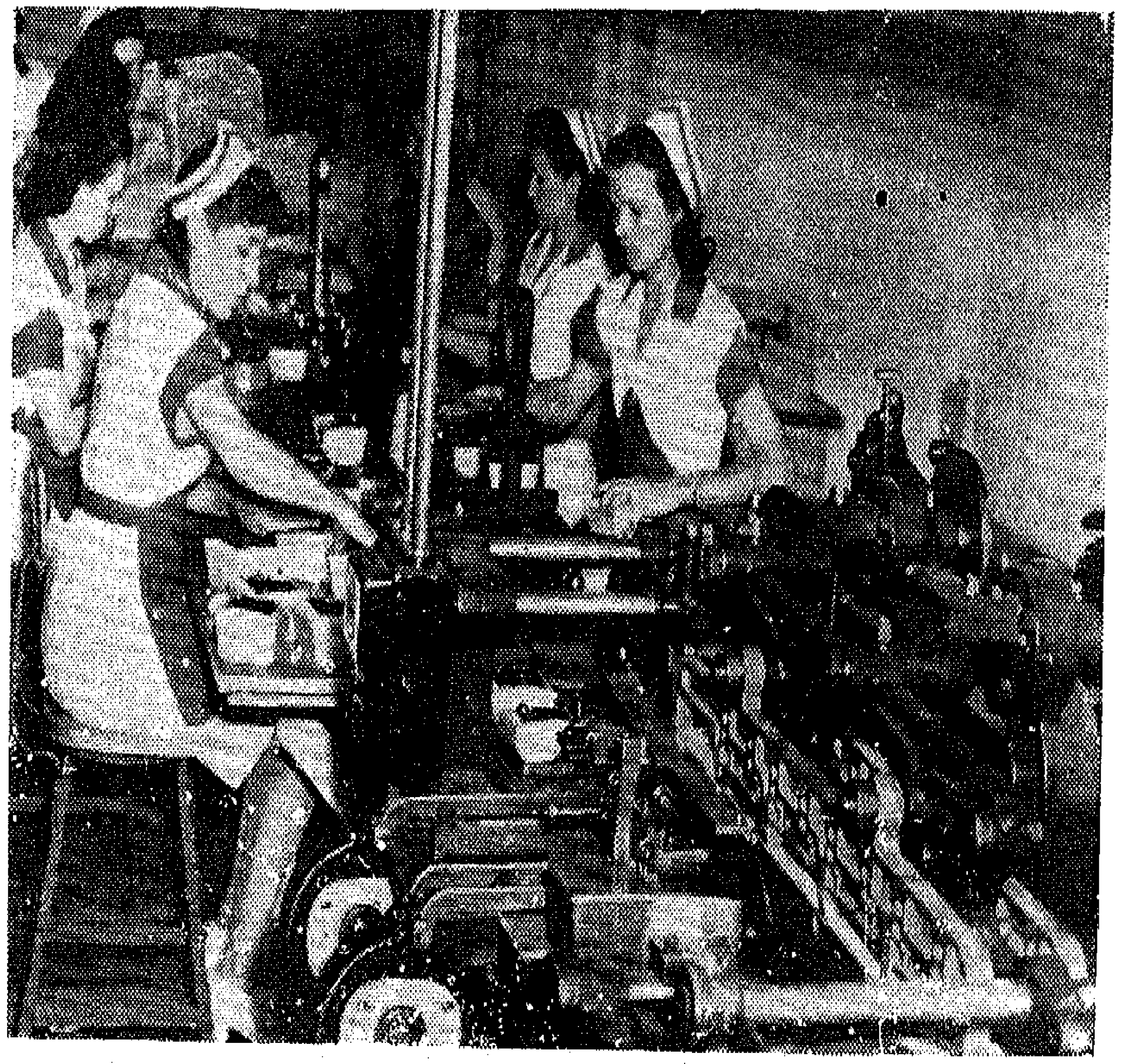


FIG. 10.—HYGIENIC DATE PACKING IN CALIFORNIA.

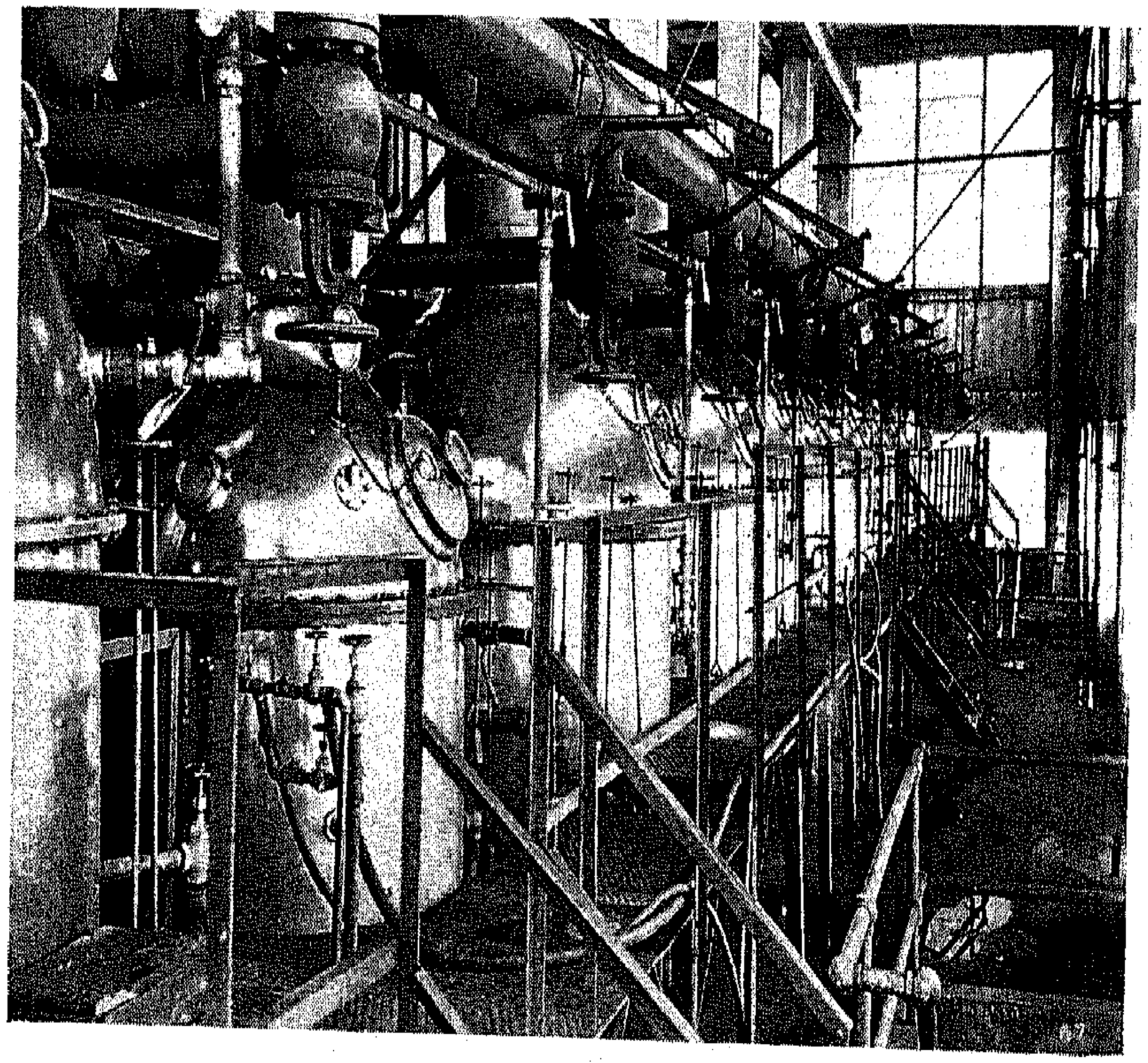


FIG. 11.—A BATTERY OF MILK CONDENSERS.

This meat contains about 30-40 per cent. oil and 50 per cent. moisture. After harvesting, the coir is removed, the broken kernels dried, and the copra extracted. The drying of the copra is accomplished either by sun rays, hot air or rotary driers. The latter method yields finer and whiter copra, which is used for the production of desiccated coconut.

Storage.—The storage of nuts, particularly walnuts and hazelnuts, demands special attention to ensure that they are adequately protected from egg-laying insects which render the nuts unusable. Immediately these nuts are received into the factory the cases should be opened and the nuts carefully examined to ascertain their freedom from eggs and larvæ. They should then be repacked in D.D.T.-treated containers and kept in cold storage until required, only the exact quantity being withdrawn when needed. Walnuts are very susceptible, and it is, unfortunately, possible to purchase a box of candies or chocolates in which walnuts have been used as a decoration only to find that the nuts are infected. All nuts, including desiccated coconut, must be kept in dry conditions to avoid rancidity.

Licorice

Source.—The chief source of licorice juice is the plant *Glycyrrhiza glabra*, which is native to Near East and Mediterranean countries. The roots of this plant are collected, dried, crushed and boiled in water. The resultant juice is strained and evaporated sufficiently to produce a brittle mass when cold. Finely ground root and possibly starch or some other drying material may be added to assist the hardening process. Whilst the product is still firmly plastic, it is cut into conveniently sized blocks for ease of handling. The extracted juice contains a glucoside which prevents fermentation, and in dry conditions the blocks of juice may be stored without deterioration for indefinite periods.

By-Products.—An interesting fact concerning the residual fibres after extraction of their juice content is that a proportion of these fibres incorporated into other material used for the production of insulating board will render that board resistant to insect attack. This property could find useful application in the walls of drying stoves connected with the preparation of almonds and other nuts in the confectionery industry.

Dried Fruits

Source.—Amongst the many varieties of dried fruits used in confectionery manufacture, the most important are figs, raisins and dates. Until comparatively recent times most of the world's supply of sun-dried fruits emanated from the Middle East and Mediterranean countries. Now, however, California has developed the sun-dried fruit industry to such an extent that it rivals the production of the former countries (Fig. 10).

Prevention of Infestation.—From the growth of the fruit to the final packaging and storage, incessant war is waged on the insects which so readily infect the fruit and cause enormous losses each year. Several methods of de-infestation are used to kill the insects and their eggs and larvæ; methods which are effective, but must be supplemented by the ultimate users if reinfestation is to be avoided. These systems consist of fumigation by gases, such as carbon bisulphide, sulphur dioxide and methyl bromide, in hermetically sealed chambers or chambers from which the air has been exhausted, the vacuum method being the more satisfactory; subjection of the fruit to heat treatment by passing it through dilute solutions of sodium chloride or carbonate at boiling point; cold storage at a temperature of 36°-50°F. for a period of 3 months, which effectively kills the insects and their eggs (Fig. 9).

Packing and Storage.—The packing of dried fruits in straw mats usually practised by Middle East packers is unhygienic and quite unsatisfactory, since there is no protection whatsoever against the depredations of insects or rodents. This form of packing applies particularly to figs and dates, and is to be deplored. When such fruits are received into the factory, they should be transferred to trays, inspected, and fumigated with SO_2 immediately before they are placed in D.D.T.-treated storage or in refrigerated chambers.

Milk

The chief forms of milk as used in the chocolate and confectionery industry are concentrated milk containing sugar, and completely desiccated milk powder.

Condensed Milk.—To produce condensed milk, tested fresh milk is heated to 145°F., passed through clarifiers, and a weighed amount of sugar in the form of a syrup is added to the milk at the same temperature. About 75 per cent. of the contained water is extracted in the condensing plant, and the resultant milk-sugar syrup cooled and simultaneously subjected to controlled crystallisation (Fig. 11).

Testing.—When received into the factory, usually in casks, condensed milk should be tested for uniformity of colour, clotting due to the formation of colonies of fat and sugar crystals, absence of any rancid or unpleasant flavour, smoothness of dispersion in water and metallic odour and taste.

Storage Problems.—Sometimes condensed milk may show a brown discoloration. This is due to exposure, during manufacture, to high temperatures or to storage in warm rooms. Condensed milk, therefore, should be stored in refrigerated chambers. As the casks in which condensed milk is packed are far from ideal containers, owing to their possible encouragement of the development of yeast cells in the contents, the milk, where possible, should be transferred immediately to glass-lined steel tanks, in which it may be stored at a moderate temperature. Scrupulous cleanliness is imperative in storage.

Sugar Content.—The presence of milk-sugar crystals in condensed milk is inevitable, since the water present (about 25 per cent.) is insufficient to dissolve the milk-sugar content (about 13 per cent.). No roughness should be apparent to the tongue on testing, since, under proper conditions, the size of the sugar crystals should be no more than 10 microns (Fig. 15).

Desiccated Milk Powder

Manufacture.—In the case of milk powder the fresh and tested milk is preheated to 190°F., evaporated, and finally spray or roller dried (Fig. 12). Preheating lowers the bacterial count of the resultant product and greatly assists the keeping quality of the powder, although a slight "cooked" flavour is developed. Unless certain precautions are taken during manufacture, milk powder acquires an unpleasant fatty flavour due to oxidation of the milk fat, a state which becomes more apparent in full cream milk powder. High moisture content leads to the development of a stale gummy flavour, to increasing insolubility and loss in nutritive value.

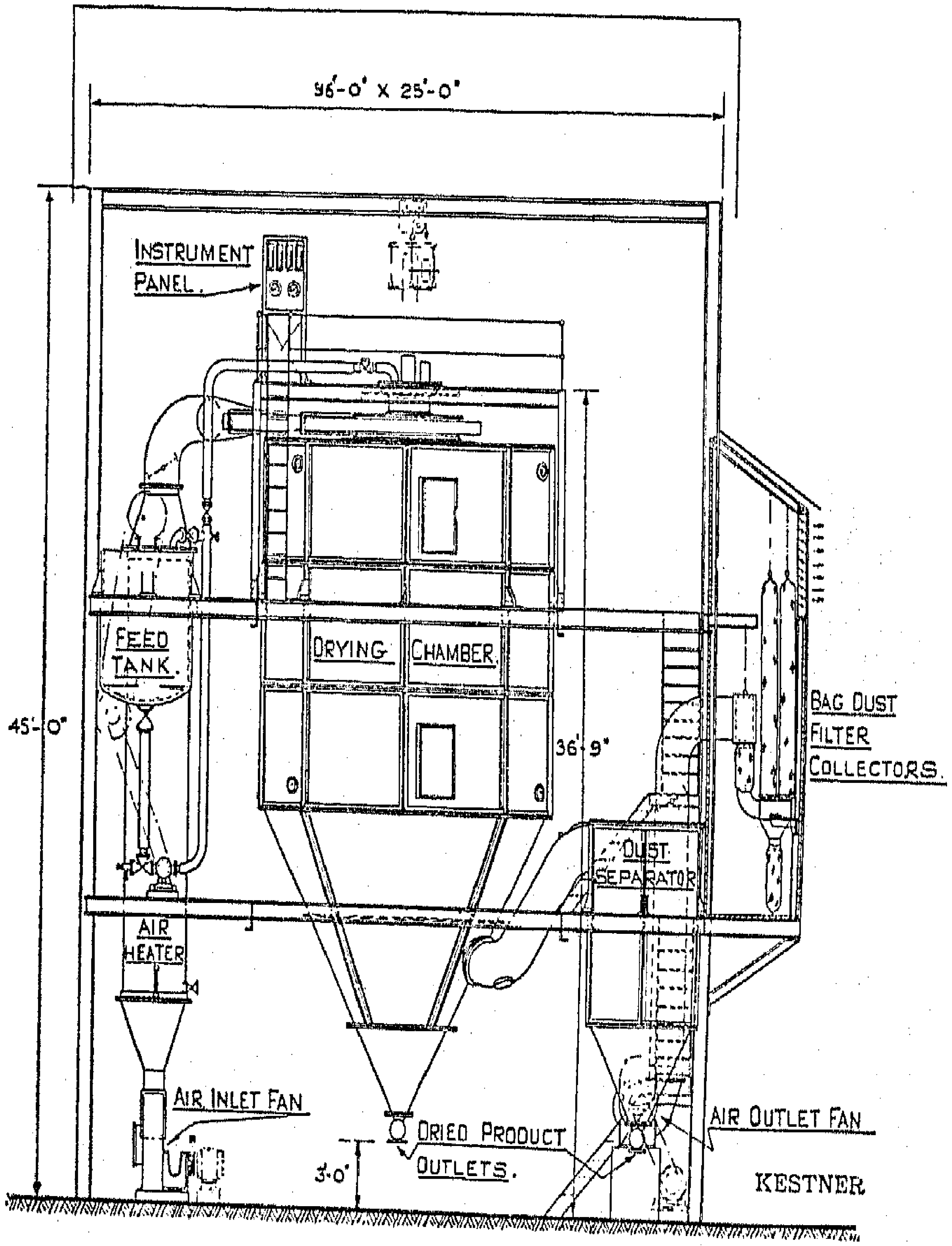


FIG. 12.—SPRAY DRYING PLANT.

Insolubility.—Insolubility is caused by the combination of a portion of the lactose with the milk proteins, whilst the loss in nutritive value is due to the adverse effect of moisture on the lysine content of the milk powder. It is, therefore, essential for the discerning manufacturer of chocolates and confectionery to

obtain a certificate of analysis from the milk powder producer, check the figure in his own laboratory, then ensure that the powder is stored in his premises under the driest and most hygienic conditions. Carelessness and half measures result in heavy losses of valuable foodstuffs (Fig. 17).

Lecithin

Source.—Lecithin is the commercial term given to a group of phosphatides present in certain types of vegetable oils. Its value to the chocolate industry lies in its high power of emulsification and its ability to reduce surface tension. The chief sources of lecithin are soya beans, groundnuts, rape seed, cottonseed and linseed oils, and the method of recovery of the lecithin is briefly as follows:

Method of Recovery.—The crude oil, obtained by solvent extraction or expression, is purified for the removal of impurities, and heated to a temperature of 60°-90°C., whilst 1-3 per cent. of hot water is stirred in to hydrate the lecithin. After a brief mixing the lecithin forms a sludge, from which the oil is separated by means of a De Laval lecithin separator. The sludge is transferred to a vacuum evaporating tank, where the excess moisture is eliminated. The resultant product is crude lecithin, containing approximately 30 per cent. oil and a fairly high fatty acid content. For use in foodstuffs, it is refined by extracting the oil with acetone in which lecithin is insoluble. The de-oiled lecithin is finally mixed with 30 per cent. refined vegetable oil to act as a preservative.

Effect on Viscosity.—It has been proved that an addition of 0·3 per cent. lecithin is equivalent to approximately 5 per cent. added cacao butter. Since lecithin is a hydrophilic colloid, its inclusion in a chocolate will assist the prevention of sugar bloom if the product is subjected to normal humidity conditions, and providing the chocolate itself is practically moisture-free.

CHAPTER VI

CHOCOLATE AND CONFECTIONERY PLANT

Chocolate and confectionery producing plant has been developed to a remarkable degree of mechanical efficiency and precision in the past 20 years, and as discoveries are made in the realm of science, so will adaptation of such findings to chocolate and confectionery machinery give rise to even greater developments. As a consequence, production becomes more automatic with attendant reduction of working costs. Intensive scientific control over every stage of manufacture reduces the margin of error and allows chocolate and confectionery to attain a very high standard of finish, whilst eliminating losses of valuable raw materials.

To produce high-class goods it is advisable to use the best possible plant and utilise to the full every available scientific device for the control and checking of materials, work-in-progress and finished goods.

The plant described in this chapter is representative of the highest class available for large-scale production, and in certain instances for continuous and automatic manipulation. Naturally, large-scale production utilising labour-saving machinery is the most desirable target, but modifications of such plant are produced to suit the capacity of small manufacturers.

CHOCOLATE PRODUCING PLANT

Cleaning and Grading

The first machine concerned is the cacao bean cleaning and grading machine, which frees the raw beans of foreign bodies, such as clay, metal, stones and fibre.

In this machine a horizontal rotary cylinder with internal worm, clothed with wove wire and meshed to make four separations, is the main feature. The four separations consist of (1) dust, (2) splits, (3) small beans, (4) large beans, with substances

larger than beans as overtail. The cleaned beans are ejected on to canvas conveyors for hand sorting. Thence they pass into elevators for sacking preparatory to Sirocco-type roasting or for direct belt or pneumatic tube conveying to the continuous roaster. These cleaning and grading machines are each capable of handling 10-30 cwt. per hour.

Unit Roasters

Sirocco-type roasters (Fig. 18) fired by gas or coke are the usual units used for roasting cacao beans; the principle involved is the passing of hot air through the material being roasted. A charge of cacao beans is placed in the feed hopper, the air in the main cylinder of the machine having previously been heated either by gas or by coke fuel. As the desired air temperature is reached, the beans are dropped into the rotating drums, which are fitted with internal deflectors to agitate the beans and allow the hot air to pass through freely. When the point of roast has been reached, the beans are discharged into a circular sieve, whose rotating scrapers keep the beans in motion as cold air is blown up through the perforations of the sieve. The cooled beans are automatically discharged through an outlet slide.

Continuous Roasters

For large-scale production, cacao bean roasting is carried out most efficiently by means of the Dunford and Elliott Rotary Louvre Continuous Roaster. This machine consists of a horizontal drum through which the beans travel positively by means of a helical worm. The drum is fitted with a series of radial plates on the internal circumference of the shell, forming channels integral with the shell into which the hot gases are admitted. The channels are covered with tangential louvres which overlap in such a way as to leave a passage for the heat to the inside of the drum and at the same time prevent any material falling into the channel, or lodgment of the beans in the louvres. The beans rest on the tangential louvres and not on perforated plates, and so the trouble due to blinding of perforation is obviated, and there is always a clear opening for the heating gases. A manifold on the stationary head at the feed end admits the heating gases only to those channels whose

Diagrammatic Arrangement of Rotary Louvre Cacao Bean Roaster.

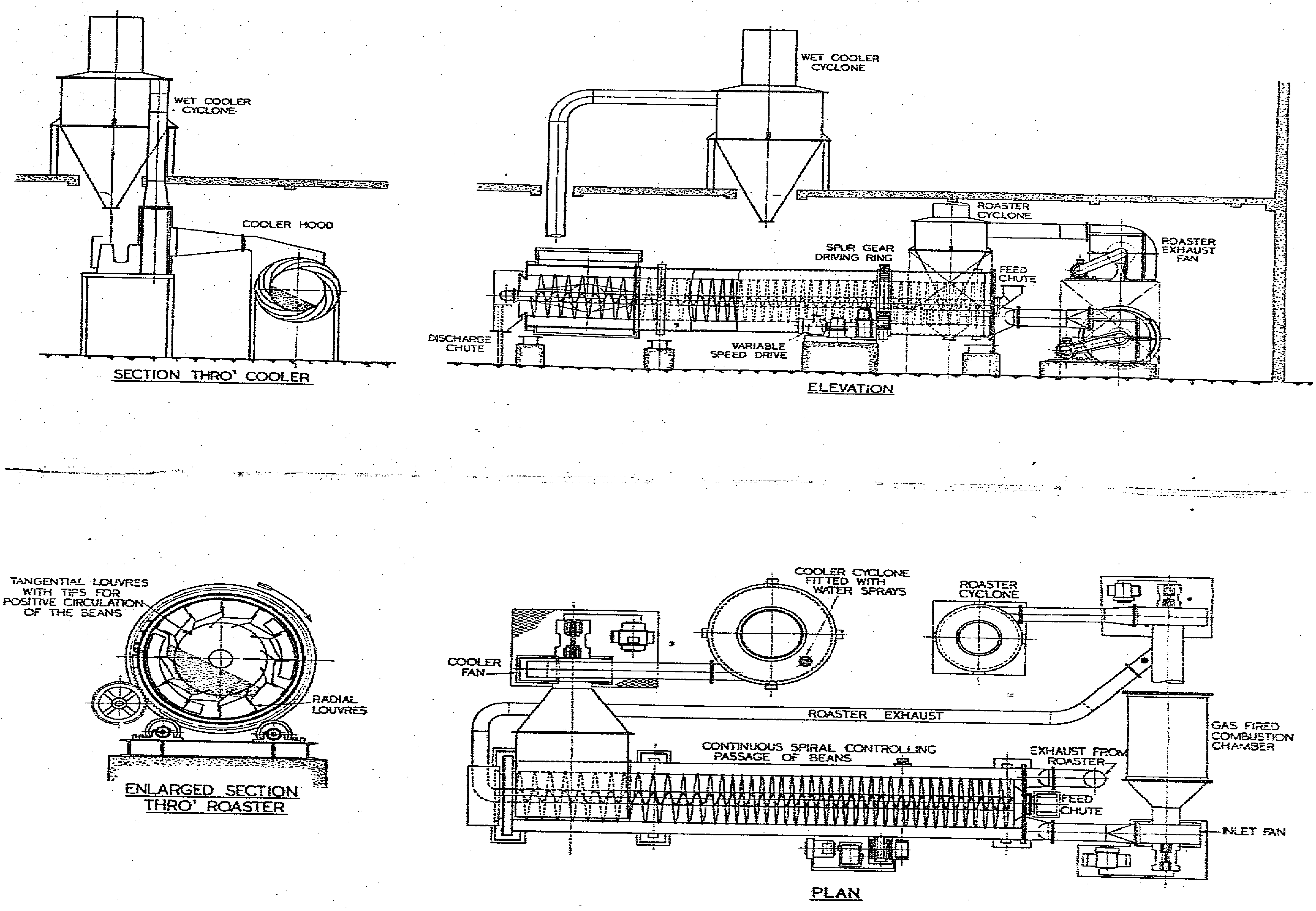


FIG. 13.

These diagrams clearly show the method of circulation of the beans through the roaster, the direction taken by the gases from the combustion chamber through the cylinder to the roaster cyclone, and the cooling system. Note the arrangement of the tangential louvres with the tips for positive circulation of the beans.

passage is beneath the charge of material, whilst the other channels are isolated from the inlet (Fig. 13).

As the drum revolves at a slow speed, fresh channels come into line with the inlet mouth, and the hot gases must pass upwards through the bed of material.

The louvre construction is so designed that the tips cause a positive circulation of the bed, taking the beans from the bottom and rolling them over the top face. In this manner the beans are roasted evenly, and there is no differential temperature between the top and bottom of the bed of the beans. Furthermore, breakage and dust formation are kept down to a minimum.

The exhaust products of the roaster are discharged at two points and are recirculated through the roaster by passing a large proportion of dust-free discharge back to the air inlet of the combustion chamber to give a high thermal efficiency to the unit. The beans pass from the roaster direct to a cooling section, which provides an instant cut-off in the roasting period, by means of a continuation of the helical screw. In this section, the cooling air is drawn through the moving and circulating bed of beans by cooler-fan, which is controlled to give approximately $\frac{1}{10}$ in. suction inside the hood and deliver the exhaust cooling air to a wet cyclone collector. The wet cyclone collector ensures the complete collection of contained husks before discharging the exhaust air to the atmosphere.

By variation of the speed of rotation of the roaster, the inlet temperature, and volume of the heating medium, any degree of roast may be obtained and reduced quantities may be treated without affecting the roasting period or quality of the roast. The inlet temperature is thermostatically controlled, and may be pre-set to any temperature between 250° and 500°C.

The capacity of the continuous roaster depends entirely on the type of roast required; a roaster having dimensions of 3 ft. 11 in. diameter, 22 ft. roasting chamber, and 8 ft. cooling section will produce a medium roast at the rate of 4,000 lb. per hour.

Steam Roasters

Steam is also used to roast cacao beans. The roaster consists of a rotating cylindrical drum of about 2 tons capacity, containing both horizontal and helical steam coils. Steam is passed through the coils at a pressure of 120 lb. per square inch, and the exhaust vapours are discharged into the atmosphere through gauze-covered openings at the side of the drum. The beans can be subjected to low, medium or high roast as required, and the time of roast is approximately 20-30 minutes.

Husking and Winnowing

From the roasters, the cooled beans pass to the husking and winnowing machines for nibbing and removal of the shell and germs. These units are of either steel or hard-wood construction. Owing to the continuous vibration engendered in the winnowers, there is a division of opinion as to merits of steel and wood as the constructional material. In the steel machine it is essential that all parts are made vibration-proof so that no rivets or bolts are likely to work loose in operation. Such precautions are equally necessary in a hard-wood machine, although wood possesses a certain amount of elasticity as compared with steel.

Method of Operation.—Whatever the material used, the principle remains the same. The beans are fed into a receiving hopper, and an elevator carries them into a breaker box fitted with adjustable hard steel toothed rollers and a magnetic separator for the extraction of any iron fragments which may have been overlooked by operators on the grading machines. A fan provides ample wind current for each section of the machine, whose main body consists of a woven wire rotary cylinder to give maximum sifting surface. In small machines the dust chamber is self-contained, but large machines of one or more tons per hour capacity require separate cyclone dust collectors to prevent clogging. The incorporation of a germ separator is necessary for good-class work, as removal of the extremely hard germ of the cacao bean facilitates later grinding.

Secondary Winnowing

If it is considered an economic proposition to carry out a secondary winnowing—that is, a further extraction of cacao nibs from the husks discharged from the standard winnower—the husks may be passed through a Bauermeister Secondary

Winnower. This machine resembles a small winnower, and from 3 to 5 per cent. of nibs are claimed as recoverable from the husks already treated. The husks are cracked and fall over a series of deflecting plates over which an air current flows. The nibs are discharged at an outlet, whilst the husk is carried through small apertures, the rate of egress being controlled by an adjustable deflecting plate.

Grinding

From the winnowers, the nibs are gravity fed into the hoppers of vertical cocoa liquor grinding mills or horizontal triple stone grinding machines (Fig. 19), in which periodic stone dressing is necessary to maintain a high degree of efficiency in operation. Developments in steel hardening have made possible the application of steel-toothed discs of especially long life to the grinding of cacao nibs, and this principle is embodied in much modern plant.

Method of Operation.—The cacao nibs are gravity fed into the feed hopper, which is fitted with an adjustable feed-control mechanism, to the first set of grinding discs for rough grinding. The liquor passes to a secondary set of finely adjusted discs, which grind the liquor to a high degree of fineness. The essence of successful grinding is the maintenance of a low temperature in the liquor throughout the operation, and this is attained by the arrangement of an efficient system of water circulation through the grinding heads. This ensures that the flavour of the liquor is not impaired by over-heating. These mills are capable of an output of 450-900 lb. per hour.

The liquor can then be pumped to the hydraulic pressing machine (Fig. 20) for extraction of cacao butter and preparation of cocoa powder, or passed to the melangeurs or mixing machines for the production of chocolate. In the latter case, the type of machine used is a matter of personal preference.

Mixers.—The mixing machine can take the form of a steam-jacketed, sigma-armed kneader of standard design which may be constructed for either atmospheric or vacuum operation. The vacuum kneader assists the elimination of moisture contained in the mass and ultimately reduces conching time.

Melangeurs

The standard type of melangeur will handle sugar and liquor mass in any degree of stiffness, and the base is heated to facilitate mixing by means of steam coils installed immediately below the bedstone. It is discharged automatically by means of a scraper chute, which draws the mass off one of the granite rollers.

Steel-Bed Melangeur.—The H.M.S. chocolate melangeur of Belgian manufacture is a machine worthy of study (Fig. 21). The smaller melangeurs contain the usual granite rollers and bedstones. The larger machines of half-ton capacity, however, have the granite units replaced by steel, which possesses a higher heat conductivity. The rollers are very much heavier than granite and do not skid over fatty products having a low friction coefficient, a fact which allows the pulverising of cocoa liquor, sugar, milk and nuts with greater efficiency. The melangeurs are completely enclosed by means of removable horizontal lids, or by a sheet metal cage fitted with balanced doors. The machine is charged by gravity through the top.

Automatic Discharge.—Discharge of the melangeur is performed mechanically by means of a tube containing a motor-driven extracting screw. The whole is mounted on a pivoting column, which is itself mobile and may be used to discharge several melangeurs in turn. The discharging of half-ton of chocolate mass takes 2 minutes.

Evaporation and Vacuum Drying

The Davy Evaporating and Vacuum Drying Plant (Fig. 22) is used to condense fresh milk and sugar for the manufacture of milk chocolate. The evaporating plant is capable of condensing a mixture of 1,300 gallons of fresh milk and 3,200 lb. of sugar to 5,600 lb. weight in one week of 48 hours. The resultant mass is mixed with 800 lb. of cacao liquor and placed in vacuum drying ovens, which reduce the moisture content from 11 to 1 per cent. in one week of 48 hours; the dried mass is known as chocolate "crumb." The vacuum drying oven consists of 12 steam-heated shelves, 3 ft. 4 in. by 3 ft. 8 in., with a space of 2½ in. between each.

Refining

The chocolate crumb is conveyed to the steel-roll refiners for precision grinding. Modern chocolate refiners have reached an extremely high state of development, and the refinement of the mass can be carried out to a satisfactory degree of efficiency. To attain maximum efficiency in refining, it is essential that, when set, the rolls be held rigidly in their respective positions and allow rapid and easy adjustment to high degrees of accuracy. An internal water circulation system ensures that the heat generated by the grinding action of the rolls is dissipated evenly and a constant temperature maintained throughout the length of the roll. Refiners are fitted with a variable speed feed-roll to accommodate different grades of chocolate when an increased or decreased volume of mass is required to be fed to the rolls. The Baker Perkins Refiner is capable of refining chocolate mass to a fineness of 25 microns (Fig. 24).

Safety Measures.—As a matter of safety to prevent serious damage to the highly machined rolls, shear-pins are fitted to the feed-roll bearing arms in the case of any foreign body entering the feed hopper; the pins, if sheared, throw the rolls out of gear whilst the trouble is located. With such a heavy duty machine as the refiner, pressure lubrication to the operating gears is a necessity and is provided by a submerged self-priming oil pump outside the frame. Naturally, scrupulous cleanliness is essential if the best results are to be achieved.

An interesting variation of the standard refiner is the Buhler Melangeur 5-roll refiner, which, as the name implies, is a combined melangeur of the kneader type and the standard 5-steel roll refiner. It has a capacity of approximately 300 lb. per hour.

Conching

Longitudinal Conche.—The refined chocolate mass is next placed in the 4-pot longitudinal conche with other ingredients, such as added cacao butter, lecithin and particular flavouring (Fig. 25). The outer casting containing the granite beds and rollers is designed to hold single or twin pots, and a single driving unit provides the motive force to the rollers in a series of 4-pots of a combined capacity of 1½-4 tons of chocolate mass.

The pots are steam-jacketed, and the temperature of the mass is thermostatically controlled, a most important point in the conching of chocolate, for reasons given in Chapter VIII. The chief features of an efficient conching machine are easy accessibility to all parts for cleaning and inspection, freedom from internal obstruction, maximum exposure of the mass to air by correct circulation, and well-designed discharging attachments.

Circular Conche.—The H.M.S. Circular Conche is of unusual design (Fig. 26), and is equal in efficiency to the longitudinal conche. It is authoritatively stated that this machine reduces conching time to 7-9 hours, and handles with equal facility stiff pastes or liquid masses.

It consists of a hot-water and steam-heated jacketed pan, fitted with four or six helicoid turbines and cages with cutting arms, to which control devices impart a double planetary motion. This system ensures a thorough kneading and aeration of the chocolate mass, allowing a free passage of air to all parts of the mass for the expulsion of volatile fatty acids. An ingenious scraper device provides perfect scraping of the vertical walls and bottom of the pan. Discharge of the mass is made by means of a central clearing valve. The capacity of these machines ranges from, approximately, 7 to 35 cwt. per charge.

Other Types.—There are a number of rotary conching machines produced in different countries, such as the Petzholdt, Postranecky, and Lehmann types, and of these the all steel Lehmann SylKonche is an interesting example. It consists of a large cylindrical drum revolving on a horizontal axis. One end is solid and the charging aperture is fitted concentrically with the axis in the other. Agitation of the mass is induced by means of ridges and scrapers fitted to the sides of the rotating cylinder and to the solid end. A steam coil system supplies the necessary heating, and an air suction device provides a fresh supply of air to the mass.

The Aasted Conche

Danish engineers, Bøggild, Jacobsen and Aasted, are responsible for the design, covered by patent, of a modified conching machine which depends on the forcing of air through a circulating mass of chocolate. The machine (Fig. 14) consists of a cylindrical jacketed vessel fitted with a central vertical driving shaft bearing mixing blades, and at the base a circular plate carrying a concentric series of static pins, which are perforated

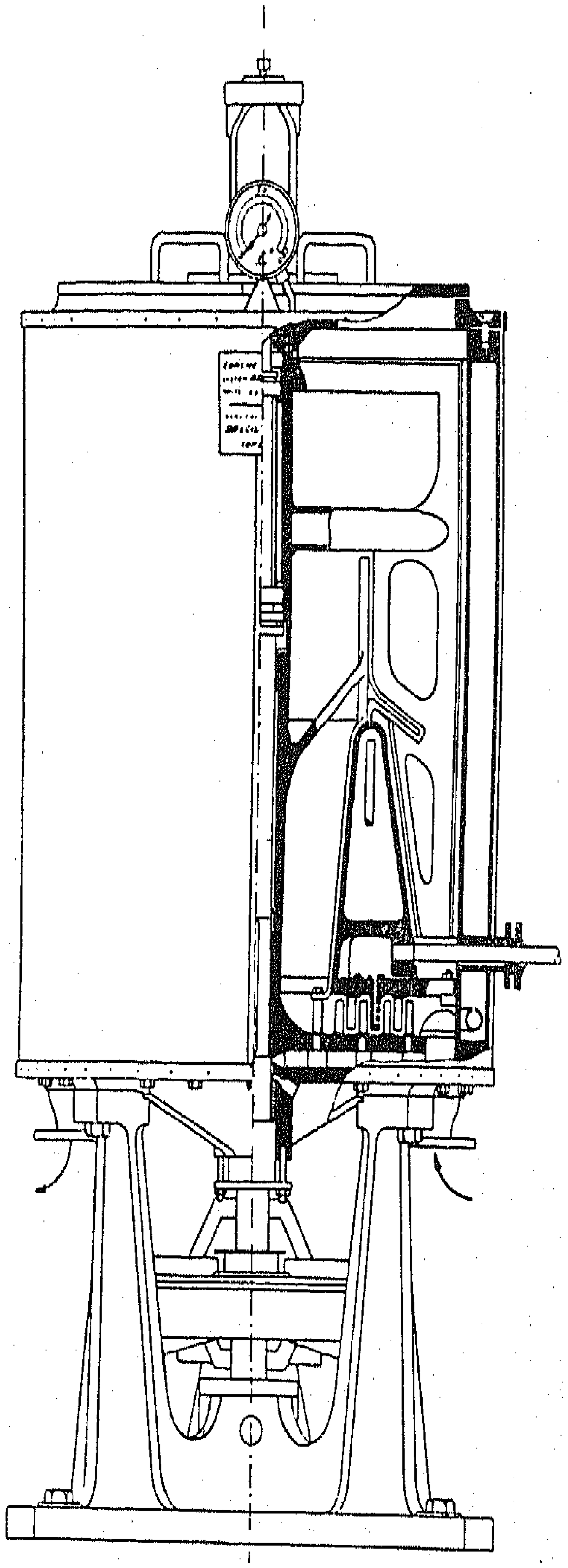


FIG. 14.—AASTED CONCHE.

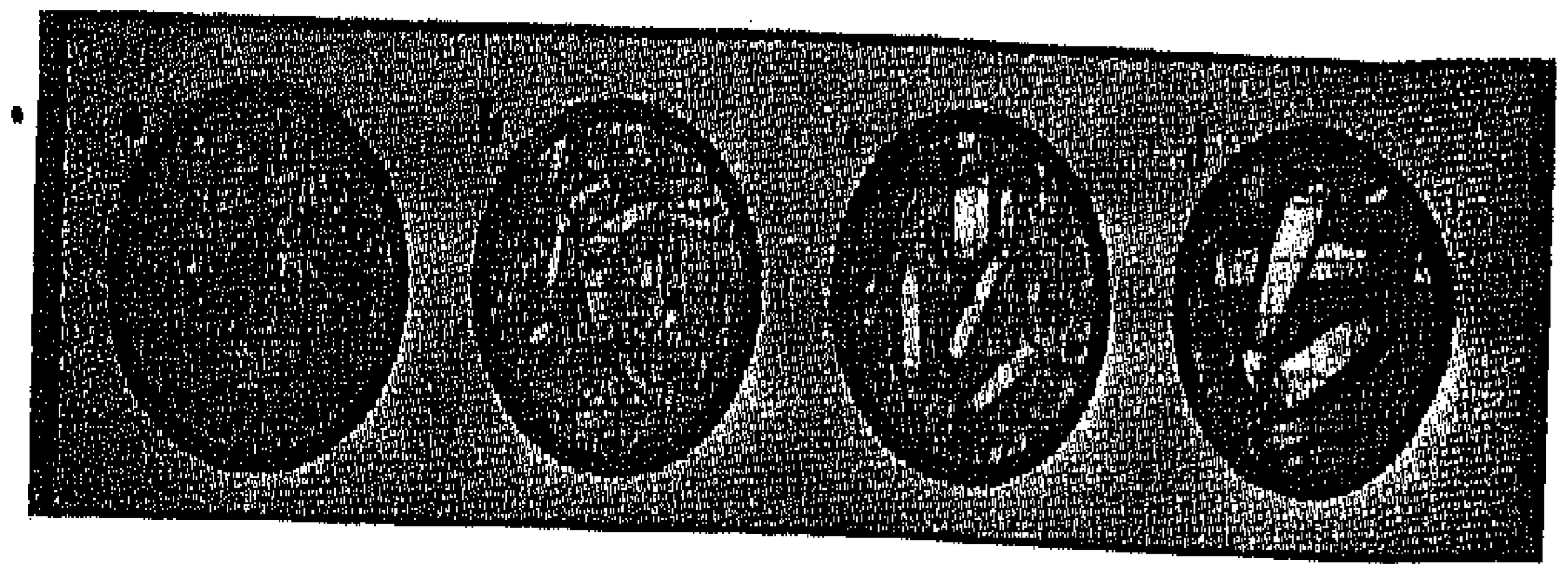


FIG. 15.—MICROGRAPHS OF CRYSTALS IN CONDENSED MILK.

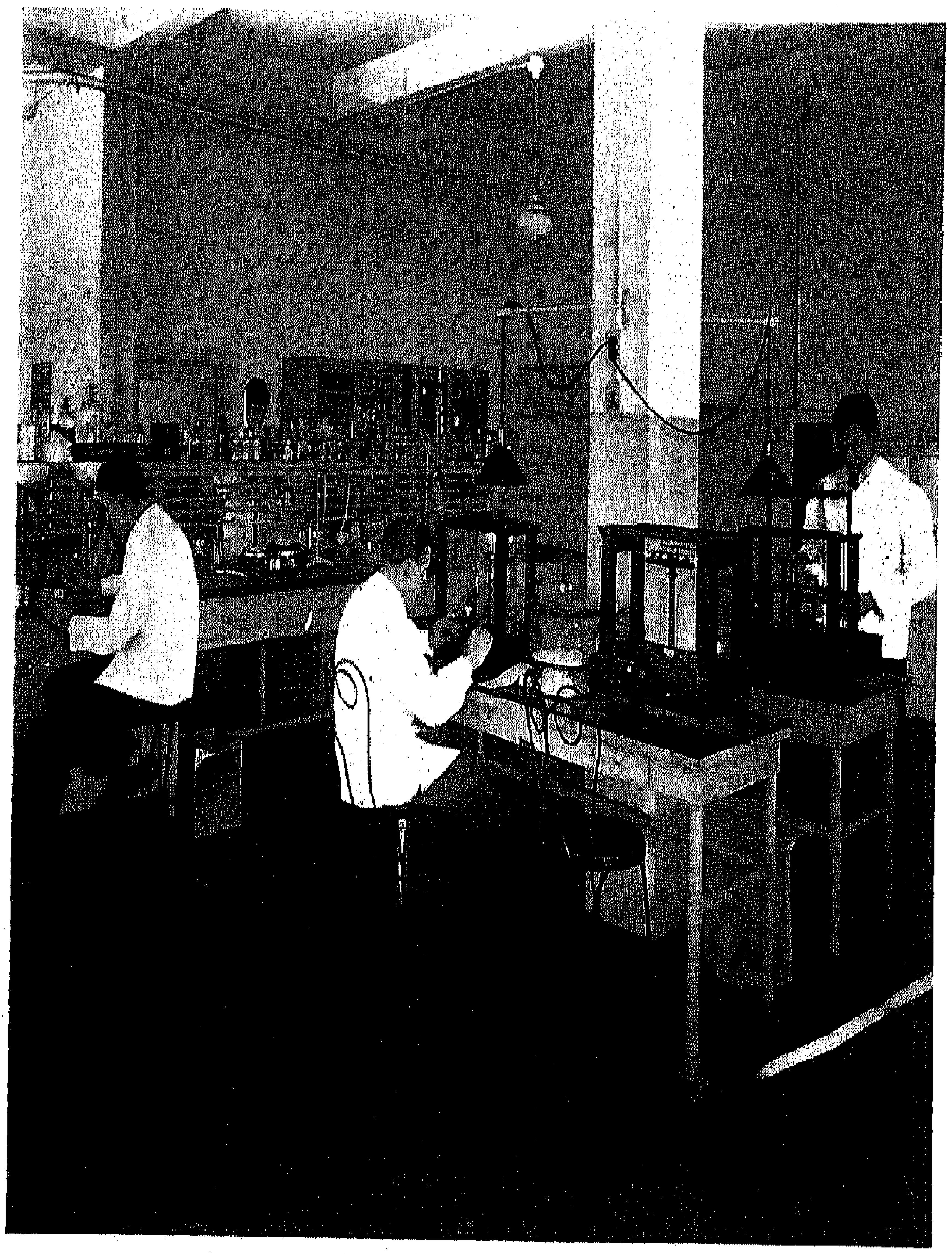


FIG. 16.—MILK TESTING SECTION OF THE HERSHEY WORKS LABORATORY.

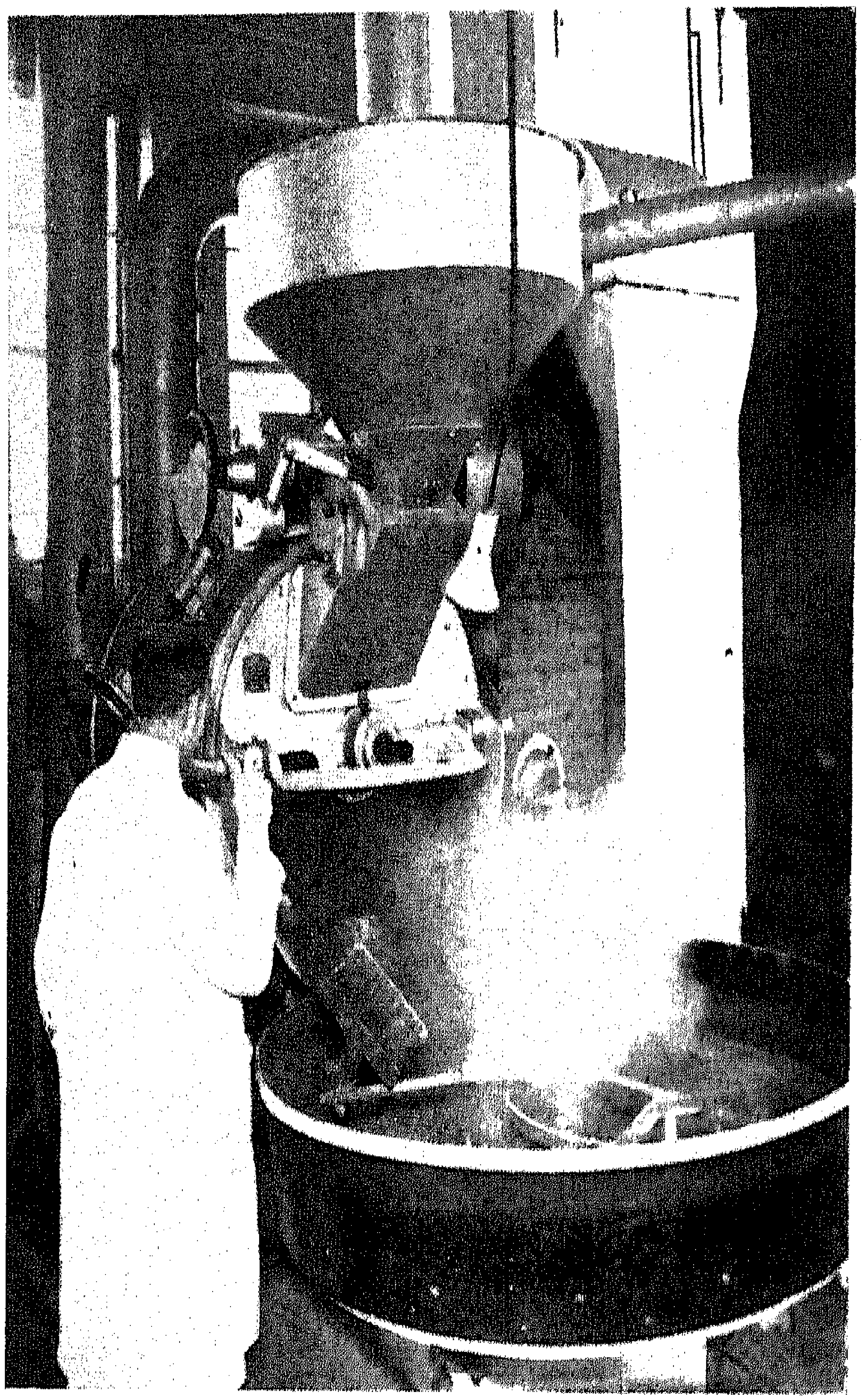


FIG. 17 – SIROCCO-TYPE ROASTER.

to allow the passage of the air into the chocolate mass. An inner shell, open at the top, is fitted into the cylinder so that the chocolate forced by the centrifugal action of a rotating pinned disc to the periphery may ascend this inner space and flow over the top into the main body of the cylinder, setting up a continuous circulation. The chocolate mass is thus subjected to an inoculation of purified, dehumidified and tempered air under a pressure of 1·5-3 atmospheres, and a simultaneous disintegration process by the pinned disc. The introduction of two perforated plates in the main body of the machine, together with the action of the rotating blades, eliminates the possibility of dead spots occurring in the circulating mass. The machine is worked in series with a similar unit operated *in vacuo* in order to extract the remainder of the contained air.

The object of the inventors was the reduction of conching time and an improvement of the degree of refinement of the chocolate as compared with the longitudinal reciprocating conche.

The Aasted Chocolate Aggregate

The Aasted conche is worked in series with a plasticator, refiner, mixing tank and Trio storage tanks to form what is called the Aasted Chocolate Aggregate (Fig. 27). This well-conceived combination of chocolate manufacturing machines is worthy of careful study, since each tank is connected by 2-in. diameter water-jacketed pipes fitted with pumps, and the mixed chocolate mass is conveyed from the plasticator and subsequently the refiner to its next unit by means of conveyor belt. The aggregate eliminates manual handling throughout the process of manufacture.

Plasticator

The primary unit is the plasticator, which takes the place of the standard melangeur. The principle of the unit is based on the fact that the newly mixed chocolate mass is immediately transposed into plastic consistency under heavy pressure. In the plasticator (Fig. 28), which is a U-shaped jacketed machine of nearly 2 cwt. (100 kilos) capacity, fitted with mixing arms and cover, the mass is subjected to a constant heavy pressure, the result being that increased amounts of cacao butter are pressed out of the cocoa particles of the liquor. The machine is so constructed that the constituent raw materials—ground sugar, cocoa liquor, cacao butter, lecithin and, if required, milk—are fed in controlled quantities into the pressure vessel through pipes either under pressure or gravitationally. This is a very desirable hygienic system of charging which also reduces handling to an absolute minimum. The plasticator is fitted with an adjustable lecithin pump which is operated by a plunger giving the exact amount of lecithin required to each charge of chocolate mass. After the requisite mixing in the plasticator, the mass drops to the base of the machine and passes through an extruder on to a canvas conveyor belt which carries it to a 5-roll refiner. After refining, the mass is transferred by conveyor belt to the mixing tank, in which it is brought to a plastic state by heating and the addition of the required amount of cacao butter. This mixing tank is somewhat similar to the standard chocolate mixing kettle and performs the same function. The discharge outlet in the base of this mixing tank is directly coupled to the conche by a water-jacketed pipe fitted with a pumping unit. The mass in the mixing tank is pumped into the conche as soon as 7½-8 cwt. (400 kilos) of mass have been treated.

Operational Control

The temperature of the conche, which has already been briefly described, is thermostatically controlled, whilst an ingenious system of bearing lubrication prevents particles entering the packing of the central shaft which passes through the base plate of the conche. The input of pressure air for the aeration of the chocolate mass is registered by a special air pressure meter, and is adjustable according to the type of chocolate under treatment. All starting switches and electrical control meters are centralised on one control panel, so that the task of the operator of the plant is simplified. A conching period of 2½-3 hours is sufficient for the highest quality chocolate, and as the output of the plasticator is 6½-7 cwt. (350 kilos) per hour, one of these machines is capable of providing sufficient mass for two conching aggregates, the total output being governed by the capacity of the 5-roll refiner.

Storage.—Subsequent to conching, the chocolate is pumped from the conche into storage tanks, called Trio-tanks, which are water-jacketed cylinders fitted with stirrers similar in action to the standard chocolate mixing kettle, and a chocolate circulating pump.

Precautions.—The following stipulations are made by the inventors regarding the most efficient manipulation of the liquid chocolate in these storage tanks. First, the chocolate is continuously pumped from the bottom of the Trio-tank to the top to create a constant vertical flow of mass to prevent sedimentation, and the speed of this circuit should not exceed 10-20 times the maximum rate at which particles of chocolate will settle in the mass at rest. The rotation speed of the wall scrapers must be such that the temperature of the scraped-off particle does not fall more than a few degrees Fahrenheit. The chocolate is stored, in constant motion, for a period of 16 hours, and the final temperature should be approximately 95°F. (35°C.). The chocolate is then ready for pumping to the tempering machines preparatory to use in the coating or moulding machines.

Ultrasonic Conching

A continuous conching machine employing ultrasonic treatment is the subject of the Swedish invention of Nordenskjöld and Holmquist. Chocolate mass is made in the usual way and subjected to an adequate refining process. The refined mass is thoroughly mixed with additional cacao butter in a mixing kettle, the outlet of which is directly connected with an elongated inclined container fitted with baffle plates at the sides in alternate fashion so that the mass will pursue a zigzag course down the container. Ultrasonic oscillators are placed in the path of the flowing mass at the end of each baffle, which also contains an air slit through which air may be forced into the mass to assist the chemical and physical actions which take place. The ultrasonic treatment is intended to cause the dispersion of the introduced air, further reduction of the particle size of the mass and possible acceleration of the necessary chemical changes required to produce a satisfactory chocolate. The chocolate is treated with ultrasonic oscillations with a frequency of 327 kilocycles per second, and mass which is tempered to a temperature of 87°-88°F. increases its temperature to 136°-137°F. after 30 minutes' treatment without the addition of external heat.

McIntyre Combination

The McIntyre Refining Machine is an ingenious self-contained unit which produces the finished chocolate from a charge of roasted nibs, granulated sugar and cacao butter (Fig. 30). It combines the functions of the liquor mill, melangeur, refiner and conche. The machine consists of a water-cooled cylinder lined with thin steel bars ranged to give a maximum grinding surface. A series of flat steel bars mounted on springs rub against the grinding bars, the pressure of these bars being controlled by an external hand-wheel. The capacity of the McIntyre plant is 10 cwt. per 8-40 hours, according to the degree of fineness required in the resultant chocolate. The conching process is effected by a fan drawing air over the agitated chocolate.

Chocolate Tempering

The chocolate, after conching, passes either into hot-stoves maintained at 130°-140°F., or to standard melting and tempering kettles. These kettles are water-jacketed, heated by steam coils and are produced in capacities varying from 150 to 2,000 lb. The latest models possess a piston-type discharge outlet containing an electric element to prevent caking. The final tempering kettles are thermostatically controlled, so that a constant supply of correctly tempered chocolate is available for use either in enrobers or moulding machines. The chocolate is pumped to these machines through water-jacketed pipe-lines, maintained at the correct temperature throughout.

The automatic tempering of chocolate mass may be accomplished by means of the Stephens, Smith Automatic Tempering Machine (Lauenstein type) (Fig. 29). This interesting machine consists of a horizontal water-cooled cylinder fed by

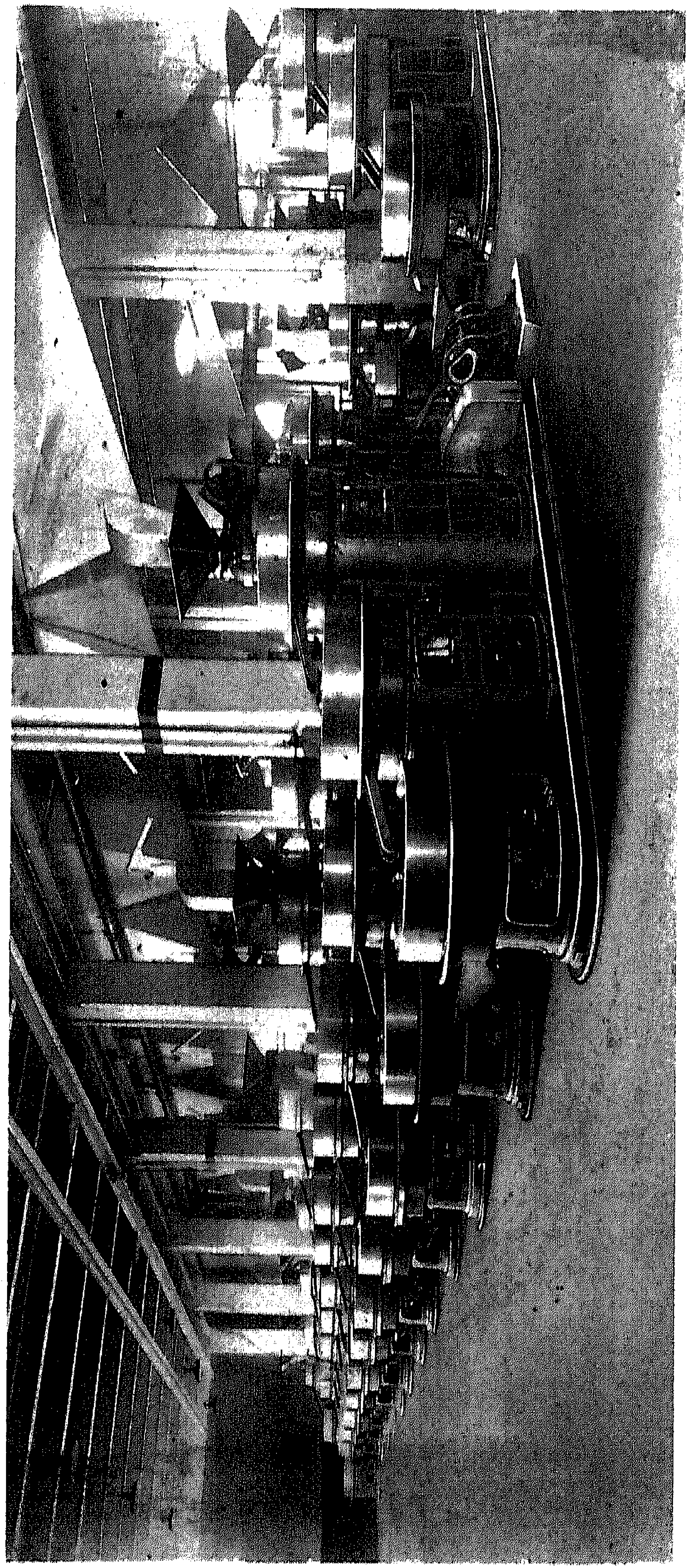


Fig. 18.—Battery of Triple Cacao Liquor Grinding Mills. (Horizontal stone type.)

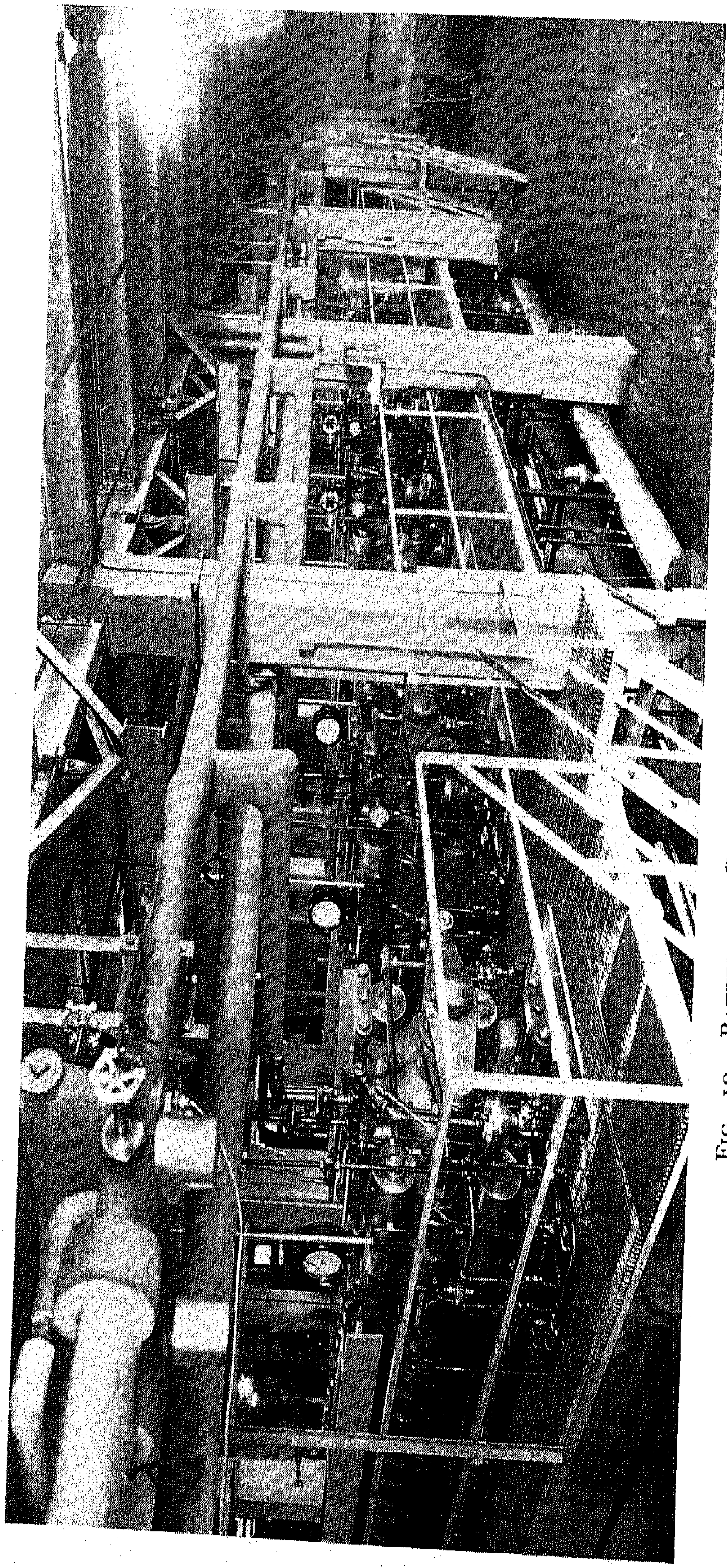


FIG. 19.—BATTERY OF CARVER HORIZONTAL COCOA PRESSES.

means of a 400 lb. capacity hopper and fitted with a specially designed worm which causes a 4-mm. film of mass to traverse the cylinder. As the chocolate passes through the cylinder, it comes in contact with three thermometer rings spaced between sections of the cylinder; the first two instruments registering the progressive cooling temperatures and the third controlling the final raised temperature at the discharge outlet. Each thermometer dial is fitted with verniers, which are set at predetermined readings on the dial. If the temperature rises above the vernier point during operation, the thermometer needle makes contact with the vernier, causing an electrical current to operate a water valve on each particular section of the cylinder.

The thin layer of chocolate traversing the cylinder responds rapidly to the action of the cooling water and the temperature of the mass is maintained to within $\frac{1}{5}$°F. of that of the vernier setting. Warm water is pump-circulated through the jacket of the final section of the cylinder to raise the temperature to the required degree prior to moulding and coating. The temperature of the warm water is controlled by the vernier of the third thermometer. The machine is fitted with an overflow pipe connected with the feed hopper, which takes care of the mass in the event of both outlet valves being closed. A variable speed drive controls the rate of flow of the mass according to the temperature of the cooling water. The capacity of the T5 model is 10 cwt. per hour, according to the temperature of the cooling water and the viscosity and initial temperature of the chocolate mass.

Chocolate Coating

The modern enrober for coating confectionery centres is a streamlined unit of high efficiency, and combines all the known aids to successful chocolate coating. The new model Greer Chocolate Enrobing plant, comprising a pre-bottoming attachment, refrigerated cold slab, coater, multi-tier and hi-gloss cooling tunnels, represents a productive unit of a high standard of technical development embodying constructional features which facilitate close control of high-grade coating and achievement of considerable production.

Pre-Bottoming Attachment

The new Greer Pre-Bottoming Attachment, fitted with a larger bottoming roll than hitherto, provides longer contact between centres and chocolate, ensuring a thicker and stronger chocolate base (Fig. 31). The chocolate tank is water-jacketed, and the temperature subject to instant control. Electric elements are fitted to keep the tank warm, if necessary, when the machine is at rest. The wire conveyor carrying the centres over the bottoming roll projects over the edge of the tank, so that tailings and unwanted pieces of candy drop into a receiver before reaching the chocolate tank. The attachment is fitted with a motor-driven adjustable rod detailer to trim any tailings of chocolate from the base of the centres.

Greer Refrigerated Cold Slab

The centres then pass over a Greer Refrigerated Cold Slab to harden the chocolate bottom. The cold slab is slightly convex so that the conveyor belt is tightly held against the refrigerated plate to ensure efficient heat transfer. The cold slab has an individual refrigerating unit fitted beneath it so that uniform cooling can be achieved under any atmospheric conditions. By setting the controls for the prevailing dewpoint, condensation on the slab is reduced, so that the conveyor belt is not affected deleteriously. The cold slabs are constructed in two sizes, 10 ft. and 15 ft., the longer unit giving a higher rate of production.

Greer Chocolate Enrober

The Greer Coating or Enrobing Machine embodies many developments which are essential to the production of high-class work under the best mechanical conditions (Fig. 31). The machine is completely jacketed, with the heating unit in the annular space between the walls of the casing. Surplus chocolate is blown off the centres by a double jet in a universally adjustable air chamber. Jacket water is recirculated through the system by pump, allowing more uniform control of temperature. The main supply tank of the machine is divided into two compartments, one of which contains the tempered chocolate, and the other slightly warmer fresh chocolate, which is gradually drawn into the tempered compartment at the same rate as the chocolate is expended on the centres. The tempered chocolate is circulated by means of a special jacketed pump which pumps it from the supply tank through a tempering unit on to the centres. A positive circulation of tempered water through the tank jackets is a further refinement of rigid temperature control of the chocolate.

The Greer Enrober has been streamlined insomuch as, where possible, sharp angles have been rounded off so that chocolate cannot lodge in corners. This is an excellent hygienic idea which is so important in the production of chocolates and confectionery. The machine is well equipped with well-placed thermometers so that the operator can readily check the condition of the machine and its contents. The enrober is produced in three sizes—*i.e.*, 24-in., 32-in. and 42-in. width bands, with a speed range of 6-24 ft. per minute.

Greer Hi-Gloss Cooling Tunnel

The Greer Hi-Gloss Cooling Tunnel consists essentially of a highly glazed conveyor belt passing through a single-tier tunnel cooled by a self-contained refrigerating unit, which is an integral part of the tunnel (Fig. 33). The chocolates are discharged from the enrober band on to the glazed tunnel band, the first section of which is air-cooled and allows for decoration of the goods. Cooled air from the refrigerating unit is blown into the bottom of the tunnel under the conveyor belt. This air flows the entire length of the tunnel to the unloading end, where a booster blower draws it from beneath the belt, and discharges it over the goods in a counter flow direction. It is then drawn back into the refrigerator and the cycle is repeated. This system allows the coldest air to set the chocolate bottoms quickly, whilst it tempers the air coming in direct contact with the chocolates, the return warmer air meeting the goods at an early stage of progress through the tunnel. This gives gradual and effective cooling and eliminates any tendency for the chocolate to case-harden and cause retardation of the release of latent heat. An important feature of the hi-gloss cooler is the incorporation of a sectional steel belt, which carries the glazed conveyor belt through the tunnel. The chief advantages of the steel carrier belt are its higher conductivity of heat from the bottoms of the chocolates, and its perfect support of the glazed conveyor belt, thereby prolonging the life of the latter.

Greer Multi-Tier Cooler

Multi-tier cooling tunnels are designed to provide maximum cooling time in a minimum of floor space. The Greer Multi-Tier Cooler (Fig. 34) is a tray-type conveyor, fully automatic and continuous in action. Chocolate-coated centres are transferred from the enrobing machine belt on to glazed fabric plaques fastened at the forward edge to steel plaque rods; the plaques are approximately 4 ft. long. A timing device on the feeding belt leaves a space at the appropriate interval so that no chocolates can fall between the plaques (Fig. 20).

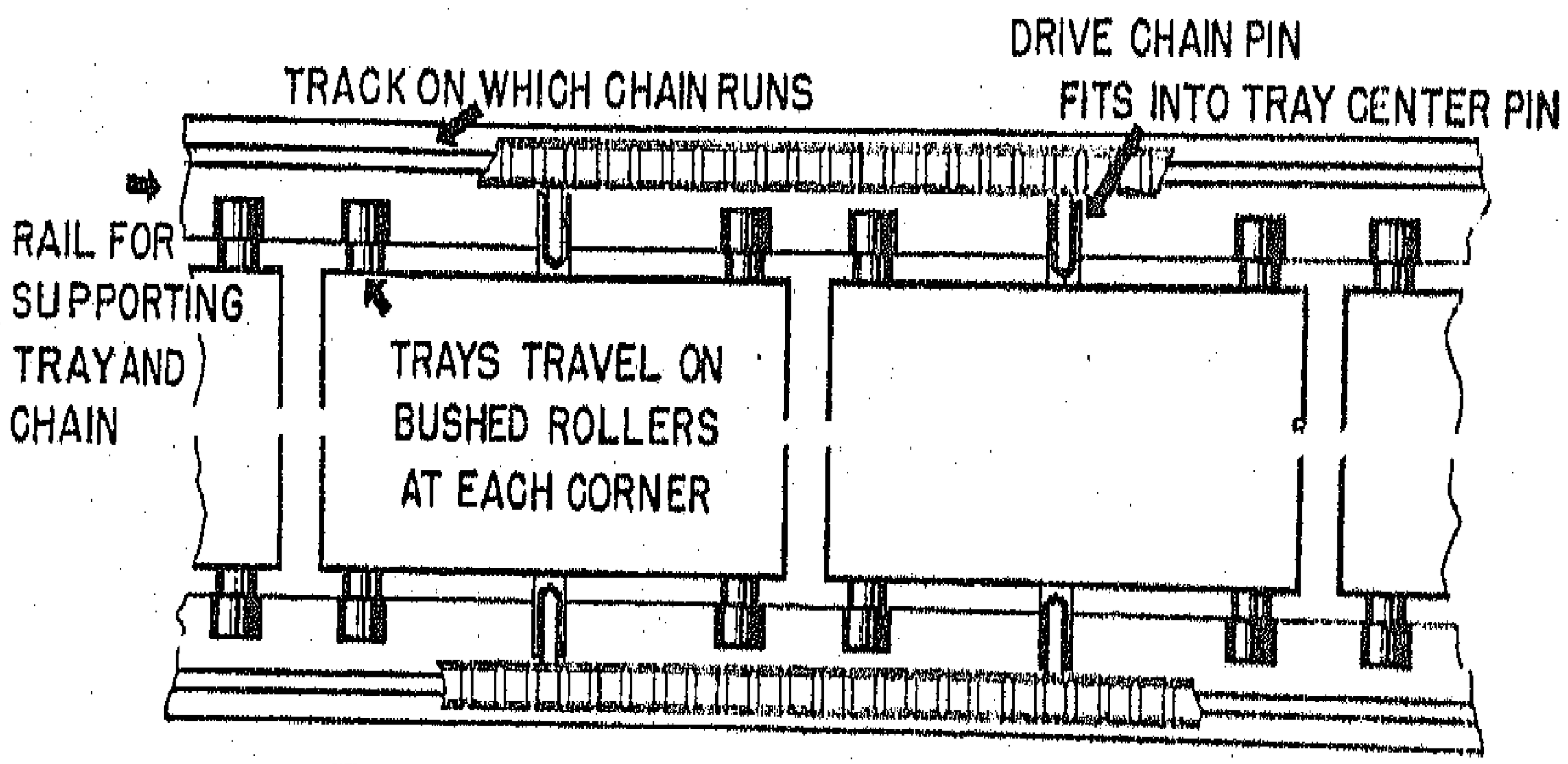

TRACK ON WHICH CHAIN RUNS
DRIVE CHAIN PIN FITS INTO TRAY CENTER PIN
RAIL FOR SUPPORTING TRAY AND CHAIN
TRAYS TRAVEL ON BUSHED ROLLERS AT EACH CORNER

Fig. 20.—Greer Multi-Cooler Mechanism.

Filled Plaques.—The filled plaques travel along the decorating section on the conveyor and are automatically placed on the steel conveyor trays at the loading end of the cooler. The trays move upward to the top of the conveyor, and progress forward and back through a succession of horizontal tiers working their way downward until they reach the discharging point. Here the plaques are automatically removed from the trays and the chocolates stripped on to the packing conveyor belt. Stabilisers at the end of each tier keep the trays perfectly horizontal from the time they enter the cooler until they are transferred to the packing belt.

Empty Trays.—The body of the cooler consists of a structural steel framework of parallel pairs of rails along which the trays

run. The empty trays are returned from the unloading point, under the main conveyor, and plaques and trays are synchronised to arrive at the reloading point simultaneously. At this point, a fixed cam automatically takes the plaque rod from the plaque conveyor chain, locks it on to the leading edge of the tray, and the filling operation is repeated. The refrigerating unit is an integral part of the cooler, and the complete plant from automatic feed to packing conveyor is controlled by one main variable-speed drive.

When it is considered that for an expenditure of 48 ft. of floor space a possible 600 ft. of cooling tunnel is achieved, giving 60 minutes of cooling time at the rate of 10 ft. per minute, the space conservation value of the multi-tier cooler becomes apparent.

Chocolate Decoration

Decoration of the surfaces of the chocolate-covered centres as they emerge from the coating chamber may be accomplished by hand, hand-manipulated forks or automatic decorators. One automatic attachment is the Lehmann, which consists of wires of various contour stretched cylindrically around supporting discs, the unit being electrically warmed from above and adjusted so that revolving wires suitably mark the soft chocolate. Another is the Latini Automatic Chocolate Decorator, which consists of a rectangular tank in which a decorating belt of pliable material is set in a smooth, undulatory motion by rotating cranks. The belt passes beneath a longitudinal guide bar and, through a slot in the base of the tank, comes in contact with the freshly coated chocolates. Various types of decoration are made possible by specially designed perforations and incisions in the decorating belts. The belts themselves are easily interchangeable by the simple expedient of unclipping the belt from the revolving cranks and reinserting a fresh one. The Latini Decorator is mounted on the delivery section of the enrobing machine, and is self-adjustable for differing sizes of chocolates.

Refrigerating Plant.—It is important that the refrigerating plant operating the cooling tunnel is maintained in a state of maximum efficiency, and should be duplicated where possible, in case of breakdown. The discharge end of the cooling tunnel conveyor can be fitted with a superstructure of conveyors or racks for the direct packing of chocolates.

Chocolate Moulding Plant

Modern chocolate moulding plant has been developed to a very high pitch of mechanical efficiency, and associated with such plant we have distinguished names such as Lehmann, Max Loesch and Jensen. The Jensen is a completely automatic unit: a depositing, moulding, tapping, cooling and de-moulding plant worked in series with wrapping machines (Fig. 36). It is capable of an output of 8 tons per day, and produces both solid and centre-filled blocks or bars with equal facility. The tapping mechanism vibrating the conveyor is an adaptation of the tapping table used for small output. The multi-tier system of cooling is used on all up-to-date moulding plant (Fig. 37).

Unit Depositor

The Baker-Perkins Fantafilla Depositor is a useful machine for filling chocolate moulds on a small scale. The machine is designed to fill a predetermined quantity of chocolate into a mould. The container of the machine has a capacity of 50 lb., and is fitted with an electrically heated air jacket, the heaters being controlled by a three-heat switch. Stirrers are fitted in the container to keep the chocolate in motion so that the heat is uniformly distributed. The speed of the machine depends on the skill of the operator and averages about 20-25 fillings per minute. The weight of the deposit is variable between ¼ oz. and 4 oz.

Cocoa Powder Production

The Rema Cocoa Powder Production Plant is a completely self-contained unit providing fully automatic treatment of cocoa from the pressed cake to the finished product (see Fig. 63).

Roughly broken cake is fed into a single roll crusher, having segmental toothed rolls of tempered alloy steel and an adjustable spring-loaded crusher plate of the same material. The crusher reduces the broken cake to pieces of ½ in. size and under.

The crushed cake is delivered into a stock hopper by a totally enclosed bucket elevator, both crusher and elevator operating intermittently to provide the rate of flow required. The stock hopper is coupled to a horizontal band conveyor, which carries the crushed cake in a continuous stream to a grinding mill, the feed rate being controlled by a vertical adjustable gate fitted to the mouth of the stock hopper. The driving drum of the feeder is of totally enclosed magnetic pattern, and is designed to remove any metallic matter which may have escaped previous attention.

Grinding.—The delivery chute of the feeder is arranged immediately above the hopper of an enclosed pinned disc mill, which grinds the crushed cake to a fineness of about 80 per cent. through 100 mesh (British Specifications Standard). The grinding elements comprise a pinned rotor over which is mounted a pinned stator. Although the temperature of the cocoa powder naturally increases during the grinding process, and the passage of the material through the pinned disc mill is in no way throttled, the rise in temperature is kept to a minimum.

Cooling.—From the mill, the powder is pneumatically conveyed into an expansion chamber. By reason of the enlarged volume of the expansion chamber the air stream velocity is reduced and is no longer capable of maintaining the particles of powder in suspension. These fall to a wooden platform fitted to the base of the expansion chamber. A scraper belt causes the powder to traverse the base twice to increase the time of contact with the chilled air which is blown into the expansion chamber. This prolonged cooling process assures the fixation of the colour of the cocoa powder, and gives even and complete cooling to all particles. The powder is then discharged from the chamber by scraper conveyor and carried to a unit type air separator. No screens are used in the construction of the separator, classification being accomplished accurately and continuously to predetermined requirements by an air current generated within the separator. This unit may be fitted with two hand-operated bagging-off valves through which fine and coarse powder are discharged respectively. Usually, the British "Rema" plant supplied to the latest design possesses only one hand-operated bagging-off valve through which the fine powder is discharged. The rejects outlet from the separator is connected to mechanical conveying equipment which delivers rejects automatically and continuously back to the feed inlet of the pinned disc mill for reprocessing. By this means a most advantageous improvement to processing is afforded because accumulation of rejects is eliminated.

Control of Fineness.—The degree of fineness is determined by radial adjustment of the fan blades controlling the air flow, and, within the commercial requirements of fineness usually required by manufacturers, there is a wide range of adjustment to the separator which can be effected without calling for any reduction in output capacity. The normal practice is to produce a degree of fineness of 98 per cent. through 100 mesh (British Specifications Standard). The enclosed construction of the plant, and the provision of adequate inspection covers affording ready access, assist efficiency and cleanliness of operation.

SUGAR CONFECTIONERY PLANT

Hard Sugar Goods

Hard sugar goods are produced on the open stove, utilising gas, fuel oil or coke as the heating medium; the rapid boiling steam pan with internal steam coil; the vacuum batch-cooking plant; the non-vacuum Microfilm continuous cooker or the vacuum continuous cooker plant. Modern conditions demand plant of the highest efficiency, and the continuous process of cooking is an essential to meet those conditions. The principle of vacuum cooking was first evolved by German technicians, who made the industry vacuum-conscious.

Continuous Vacuum Cooker

In the continuous vacuum sugar cooker, the sugar and corn syrup are dissolved in an auxiliary steam pan, which is fitted with a bottom outlet to allow the solution to flow into a receiver beneath it. From this receiver the solution is drawn into the vacuum chamber at a controlled rate through steam-heated

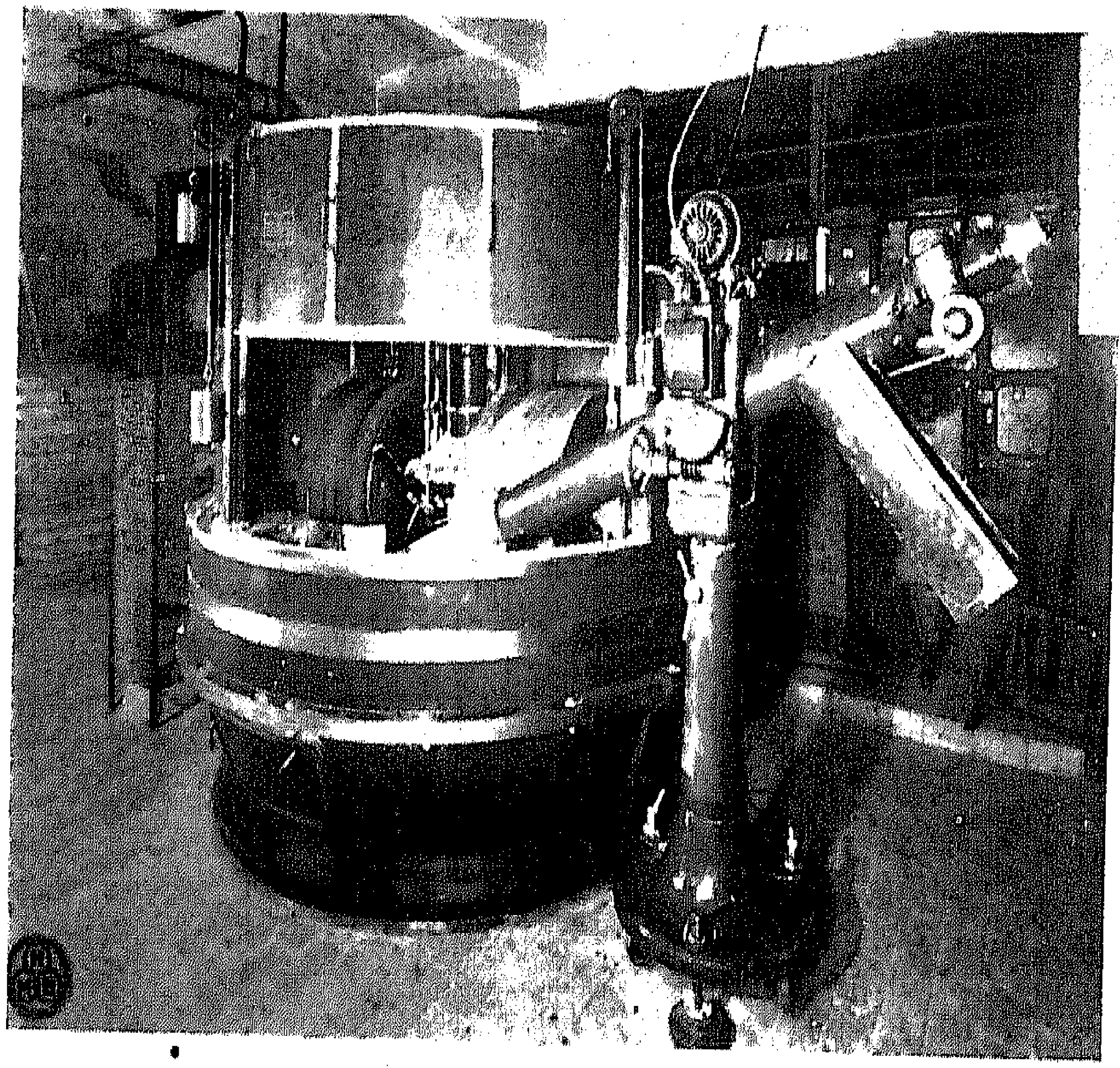


FIG. 21.—THE H.M.S. CHOCOLATE MELANGEUR, SHOWING THE AUTOMATIC DISCHARGE.

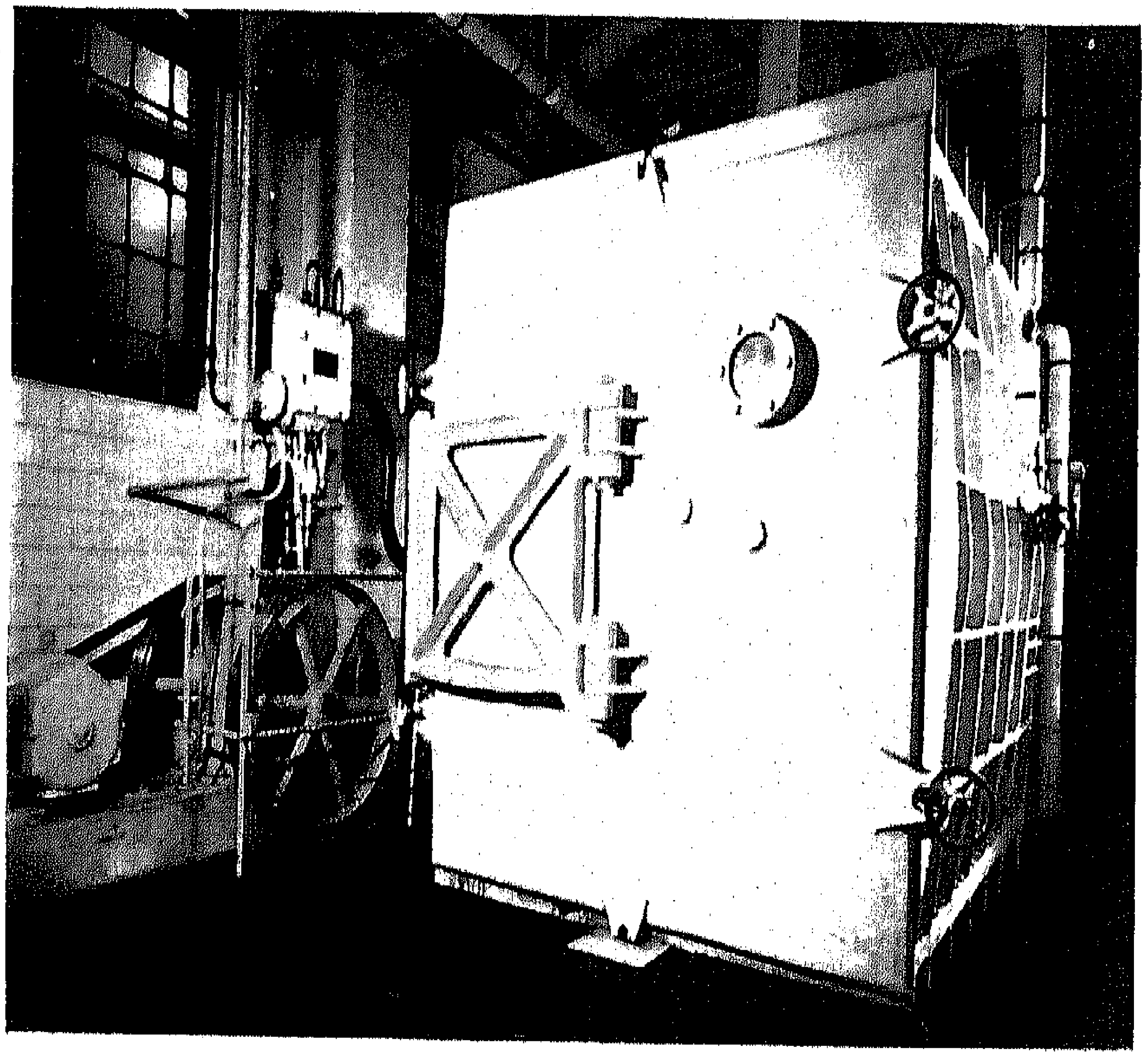


FIG. 22.—DAVY VACUUM DRYER FOR MILK CHOCOLATE MASS DRYING.

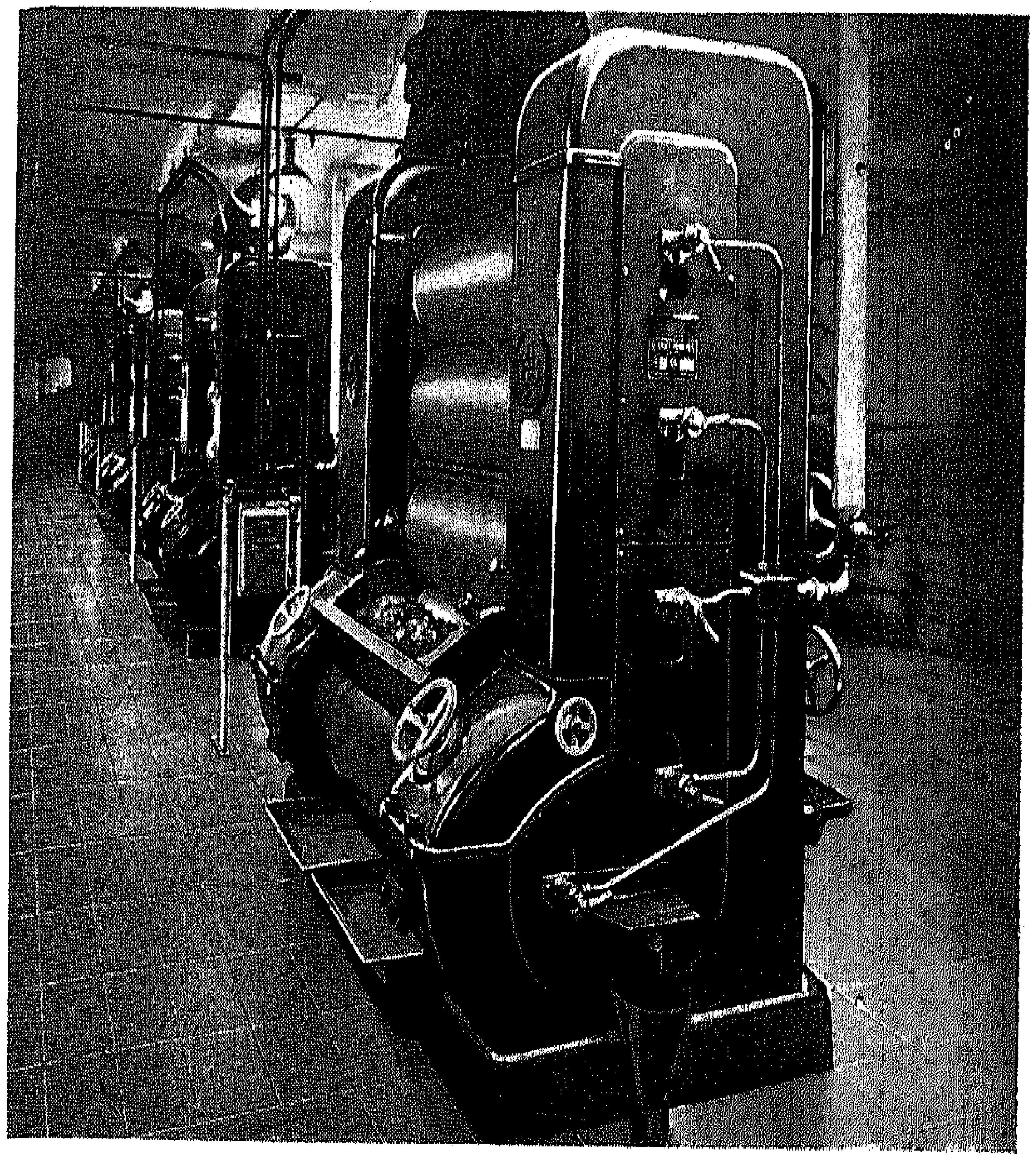


FIG. 23.—A BATTERY OF 5-ROLL STEEL CHOCOLATE REFINERS.

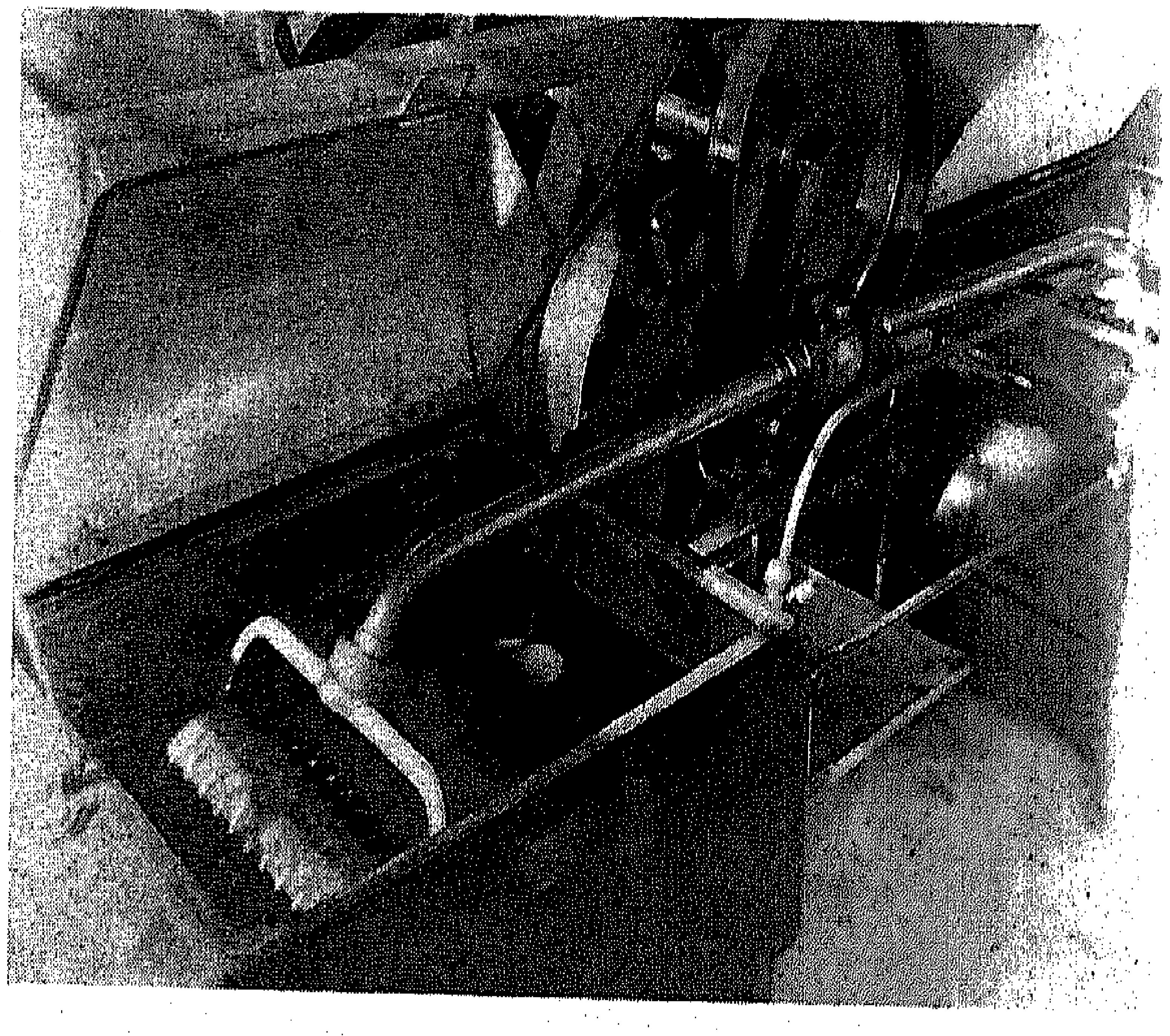


FIG. 24.—CHOCOLATE MASS IN LONGITUDINAL CONCHE.
(Note fluted roller.)

coils. The cooked mass collects in the base of the chamber to which is attached a receiving pan. The temperature of the final syrup is controlled by the rate of flow of the pump. As the syrup passes down the chamber it is subjected to heat from the outer steam jacket and from the inner exhaust tube. The contact period with heat is 8-10 seconds. When sufficient cooked mass has collected at the base of the chamber, the chamber is cut off by means of a lever, air passes into the receiving pan, allowing the syrup to drop and the pan to release itself from the vacuum chamber. The pan is drawn out on guide rails and a second pan placed under the base of the chamber to be filled in turn. These cookers are capable of outputs of 600 lb. or 1,100 lb. per hour at 80 lb. per square inch pressure.

Vacuum Batch Cooker

The Hansella VHR Batch Cooker Plant is a self-contained unit consisting of one or two steam-jacketed, tilting mixers, a vacuum dome with a detachable receiving pan and vacuum pump. The steam pressure used is usually 120 lb. per square inch. The mixers are fitted with double-wing beaters driven by shafts through the bottom of the pan, a feature being vertical slotting in one wing and horizontal in the other to set up intersecting currents for a perfect mixing action. The sugar-corn syrup solution is prepared in the mixers and drawn into the cooking pan by vacuum. When the batch has reached the required temperature, the vacuum is broken and the detachable pan containing the cooked batch pulled forward on guide rails. This and similar types of plant may be used for toffee and caramel production and for boiling the sugar-corn syrup base for nougat and other goods.

Non-Vacuum Continuous Cooker

The Baker-Perkins (Patented) Microfilm Continuous Cooker is an ingenious non-vacuum cooking unit consisting of auxiliary syrup tank fitted with wire mesh strainers and stirrers, a vertical cooking unit and a water-jacketed conical cooling table (Fig. 38). This cooker operates under a steam pressure of 120 lb. to the square inch and achieves almost instantaneous cooking of sugar under atmospheric pressure. By means of a high-speed rotor and centrifugally loaded spreader blades, a very thin film of syrup is spread upon the inner surface of a steam-heated cooking cylinder. The rapid propulsion of the syrup film over the cooking surface engenders a very great intensity of heat exchange, which makes the machine capable of high output. The cooked syrup is dropped on a rotating conical cooling table, which has a discharge aperture in the centre. The conical table is water-jacketed and an integral part of the machine. The microfilm cooker will process either all sugar or sugar-corn syrup solutions, and should satisfy those sugar craftsmen who claim that non-vacuum cooked sugar goods possess a better texture than those cooked *in vacuo*.

Tempering.—The cooked batch is manipulated on combined water-steam-jacketed steel pouring plates, flavoured, coloured and tempered to the correct state of plasticity to be placed in either horizontal or vertical batch rollers. From this point the production of hard sugar goods, with the exception of such types as rocks and count goods, is fully automatic to the wrapping machines prior to packing in containers.

Horizontal Batch Roller

The horizontal batch roller or former is fitted with cone-shaped, ribbed rollers in half-circle formation, which spin the batch one direction, then in reverse (Fig. 39). A uniform shape is maintained throughout the batch, which is itself worked into a cone, the necessary heat being supplied by a steam jacket and contained by a metal cover.

Forming and Sizing Machine

Some models have an elevating device at the wider end to facilitate feeding into the rope forming and sizing machine, which is a series of six horizontal serrated wheels fitted in pairs. Each pair of sizing wheels has individual speed control so that the sugar rope is not distorted or allowed to bunch. The machine effects a gradual reduction of the rope to the size required without distortion.

Rotary Plastic Moulder

The sugar rope then passes immediately into a Baker-Perkins Rostoplast, a well-designed continuous rotary plastic moulder. The moulded shapes are carried away from the machine by means of a single or 3-tier conveyor, which is air-cooled by ducts fitted over the conveyor band. The output of the rostoplast is approximately 1 ton per 8 hours. An ingenious design of dies provides for gradual cutting and forming, so that soft-centre goods can be handled at high speed. An interesting feature of this machine is that, unlike the earlier circular plastic die unit, the cutting and forming is performed by cams which are part of the machine and not part of the dies.

Soft-Centre Filler

For soft-centre work, jam or paste is forced into the warm batch in the batch roller by means of a flexible pipe fitted to a soft-centre filling machine (Fig. 40). This machine consists of a conical hopper to hold the soft mass, which is pumped through the pipe into the centre of the revolving batch.

Seamless Tablet Moulder

Whilst there is always to be found a very slight seam on the side of ordinary plastic bon-bons, the seamless tablet machine is designed to produce a perfectly smooth, seamless candy which is soothing to the palate. This machine is fed and discharged in the same way as the plastic machine, a feature being the ease with which it can be dismantled for cleaning purposes.

Hollow Sleeve Drop Rollers

The Bartleet Drop Roller Machine is a development of the original drop rollers and is capable of large outputs. The machine is fitted with interchangeable hollow-sleeve rollers mounted on water-cooled hollow steel shafts. Equalising rollers are mounted in front of the shaping rollers to reduce the sugar band to the correct thickness, a factor which eases the strain on and lengthens the life of the sleeve rollers. The impressed sheets of sugar mass are drawn off on to conveyor bands over which cold air is blown, and are carried to the rotary cooler consisting of trays rotating under a draught of cool air.

Lollipop Attachment

The B.C.H. Hollow Sleeve Drop Roller Machine may (Fig. 41) be augmented by a special attachment for the production of lollipops. This takes the form of appropriately designed hollow sleeves with an automatic stick feeding arrangement. This attachment is very easily fitted to and detached from the drop machine.

Automatic Balling Machine

The Bartleet Continuous Automatic Balling Machine produces hard sugar balls and rolled fancy shapes. The sugar rope is fed from the batch roller through equalising rollers to the machine. At this point the rope is automatically cut off to the required length and propelled through the delivery chute. A flap opens and allows the sugar rope to drop between three spinning rollers, which spin the rope into the required shapes. The rollers open and the shapes pass out to a vibrating cooling tray, whilst a current of cold air is blown over the goods. The shapes then pass on to the cooling conveyor in the usual way. This machine is capable of an output of 15-20 cwt. per day.

Buttered Goods

Buttered goods are, of necessity, manually produced. No enrober-type machine has yet been evolved to cover assorted centres with high-boiled sugar, and if such a machine were conceived in the future, it would be so constructed as to avoid graining of the sugar mass, an extremely difficult problem.

Essential Plant.—The usual method of producing such goods is by cooking sugar corn-syrup mixture on standard forced-draught gas or fuel oil stoves. A suitable amount of the cooked batch is placed in gas or high pressure steam heated pots fitted into circular or rectangular tables in series. The centres are dipped into the mass by operators using especially constructed spoons, then deposited on metal plaques which are placed on convenient overhead or adjacent racks. It is advisable to have

all equipment for the dipping of buttered goods metallised for thorough cleaning purposes.

Candy Pulling

The candy pulling machine, designed to introduce air into sugar mass to render it light and opaque, is a familiar feature of all boiling departments. Such machines are capable of pulling batches of 28-56 lb., and are strongly built to withstand the constant heavy strain engendered by the operation. Many types of pulling machines are fitted with metal or wood troughs below the arms to prevent pieces of the batch falling to the factory floor.

Continuous Fondant Plant

Large-scale fondant cream production is attained by the continuous automatic fondant machine, in which the cooking principle is non-vacuum film cooking. The sugar corn-syrup mixture is predissolved in standard boiling pans, drawn off into a reservoir which is an integral part of the creaming plant and pumped from the reservoir to the cooking cylinder. The cooked syrup falls in a controlled stream on to a water-cooled rotating drum, from which it is removed by scraper bars and finally deposited into the hopper of a water-cooled horizontal beating chamber. The beaters introduce air into the mass and produce a state of controlled granulation. The capacity of these machines is 500-1,000 lb. per hour.

The fondant so produced is melted with added syrup in steam-jacketed pans, and fed into the hopper of the water-jacketed depositor, or into the hopper of a depositor for filling rubber moulds travelling on a synchronised conveyor.

Mogul Starch Machine

The Mogul or Master starch machine is a complete unit embodying the whole series of operations relative to depositing, imprinting, discharging and refilling of starch trays (Fig. 42). The machine is essentially designed for large output. It consists of a water-cooled and steam-heated hopper with depositing spouts, a mould-printing press, a starch tray discharger and refiller unit, a brushing and air-draught cleaning unit for the set goods and chain conveyor all synchronised to maintain continuity.

Care of Machine.—For successful operation, the Mogul must be kept free of accumulated masses of corn starch; the corn starch itself must be warm and dry, and the starch trays made of seasoned timber, screwed or dovetailed. Faulty trays jam the machine and cause expensive delays and disorganisation. The mould-printing board consists of a series of battens in parallel carrying an overall cover of muslin of sufficiently large mesh to allow displaced air to escape and to overcome clogging. The light alloy or cement moulds are fixed equidistantly along the batten lengths so that when the printing board is pressed down on the levelled starch, a regular pattern of impressions is left in the starch. A considerable amount of poorly shaped merchandise is still produced owing to negligence in the correct setting of moulds on the printing board.

The all-steel, heavy duty Mogul M-100 of the National Equipment Corporation is an interesting example of modern plant streamlining and is worthy of careful study.

Unit Starch Machine.—For smaller output, the depositor, mould printer, and starch buck are made as separate units. The starch buck is a machine which empties the trays, cleans the goods and refills the trays with levelled starch.

Paste Depositor.—The Baker-Perkins Oka Depositor is a machine which utilises the principle of a screw plunger to deposit stiff confectionery such as praline and marzipan.

Depositor Pump Bar.—In conjunction with depositing machines the hydro-seal pump bar of the National Equipment Corporation embodies a series of grooved stainless steel pistons, which pass through a water trough contained in the pump bar. On the downward stroke of the pistons simulated water from the trough is trapped by the grooves, and returned to the trough on the upward stroke. This feature seals the pistons to the cylinders and creates automatic, continuous lubrication, and prevents jamming on the depositor. An efficient, cleanly depositing pump bar mechanism is an all-important factor in the production of goods of uniform size.

Gum Cleaning and Crystallising

The cleaning of deposited gums, pastilles and strong jellies can be accomplished, after separation from moulding starch, by means of compressed air jets, or by passing through a B.C.H. Gum Steaming Machine, which consists of a wire conveyor travelling through a chamber containing a series of steam jets, thence through an air-conditioned tunnel on a discharging band travelling at 16 ft. per minute (Fig. 48).

Dry Crystallising.—Two methods of crystallising gum goods are used. The first, a sugaring process, in which the cleaned work is passed through a steam chamber, then sifted with crystal sugar and passed over a vibrating sieve. The surplus sugar is retrieved by bucket elevator from below the sieve and kept in circulation. Drying of the sugar is accomplished by steam-heated coils placed beneath the sugaring box. In the case of some classes of pastille goods, the sugaring process will complete the finish. To fix the sugar to give a crystallised appearance, the sugared goods are transferred by bucket elevator to the wire conveyor of a B.C.H. Steaming Unit, which causes a partial solution of the surface sugar, together with a slight softening of the jelly, so fixing the sugar in a uniform crust. The capacity of this crystallising unit is 4-5 cwt. per hour, and 6-8 cwt. per hour when used for crystallising hard sugar goods.

Syrup Crystallising.—Syrup crystallisation is carried out in a Baker-Hulme (Patented) Crystallising Plant. This unit consists of a galvanised cylindrical tank, steam heated and water cooled, in which the entire process of heating and cooling the syrup and final crystallising takes place. The tank is fitted with an agitating gear and straining equipment. A batch of 80 wire baskets, holding ½ ton of goods, is transferred in and out of the tank by a crane. On completion of the crystallising process, the trays are deposited, *en bloc*, on to a circular drip tray, which receives drained surplus syrup. Two processing tanks are served by one crane fitted between them.

Marzipan Production

The plant required for the production of marzipan comprises an almond cleaning machine to remove foreign matter; a steam-heated tank containing boiling water, in which a wire basket holding the almonds can be lowered for softening; a blanching machine; mincing machine; a three-roll granite or porcelain refiner; and marzipan cooker.

Essential Plant.—The B.C.H. Blanching Machine consists of a series of rubber rollers which rub the skins from the almonds, the skins being drawn into a receiver, and the blanched nuts passing into another receiver, which is transferred to a drying room at 100°F. The dried nuts are passed through a mincing machine, thence through a refiner. The final sugar-almond paste is cooked in a marzipan cooker, which consists of a rotating, cylindrical pan inside a steam-heated jacket. The stirring gear is stationary, and attached scrapers prevent the mass adhering to the walls and base of the pan.

For large-scale operation, an automatic unit has been designed for almond grading, scalding, draining and blanching.

Almond Splitting and Slicing.—Blanched almonds are split to serve as decorations on chocolate-covered centres, and this operation is accomplished on the B.C.H. Automatic Almond Splitting Machine. This has a hopper feed from which the whole almonds are automatically discharged to the splitting unit. The machine is designed to feed the almonds lengthways into the rollers, and this system affords a much cleaner split than hitherto, when the almonds were fed in at all angles. With the automatic feed an output of 4 cwt. per hour is obtainable. A further advantage of the machine is that it will split undried almonds. A B.C.H. machine of similar type automatically feeds, strips or slices almonds into long narrow pieces at the rate of 100 lb. per hour.

Starch Conditioning

Plant for the reconditioning and dehumidification of moulding starch, which, after use, will contain particles of sweets and have absorbed a considerable amount of moisture, is an essential item of equipment in the confectionery factory.

Cleaning.—The Gardner "Rapid" Quick-Change Dresser is designed to free moulding starch from all extraneous material. The starch is fed into a feed-regulating hopper, whence it passes into an enclosed cylindrical sieve which is constructed

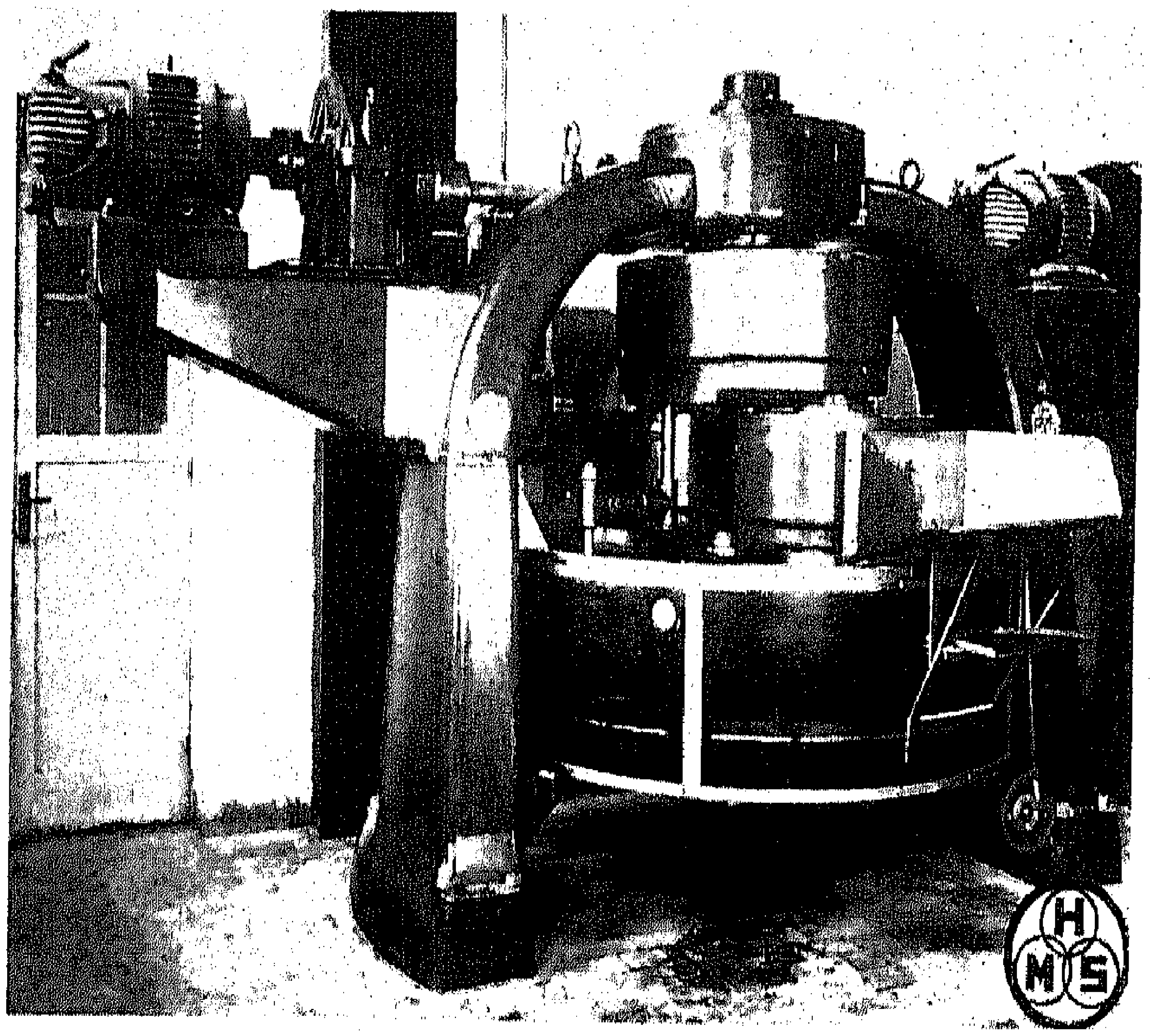


FIG. 25.—H.M.S. CIRCULAR STEEL-BED CONCHE.

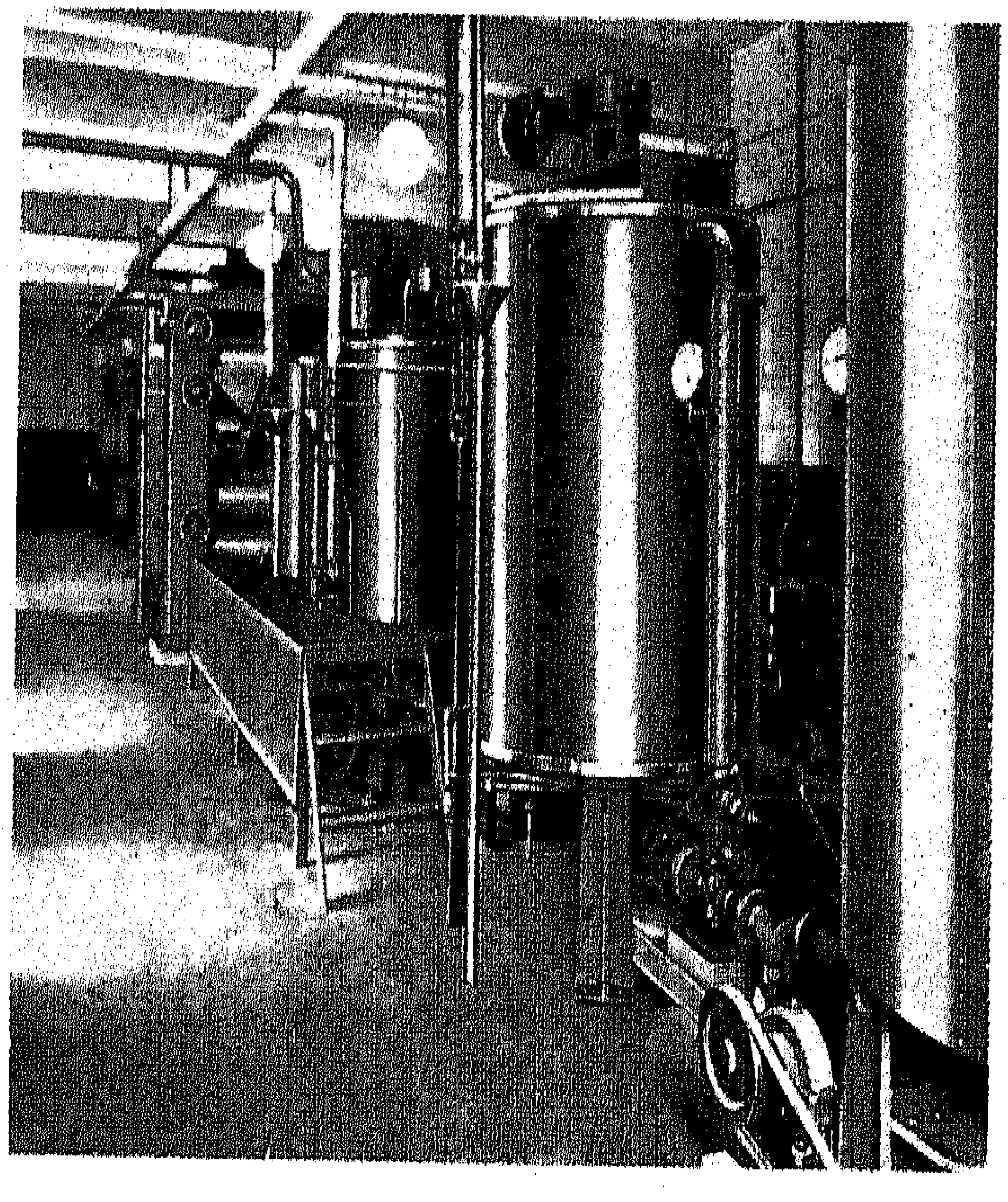


FIG. 26.—AASTED CONCHING AGGREGATE.

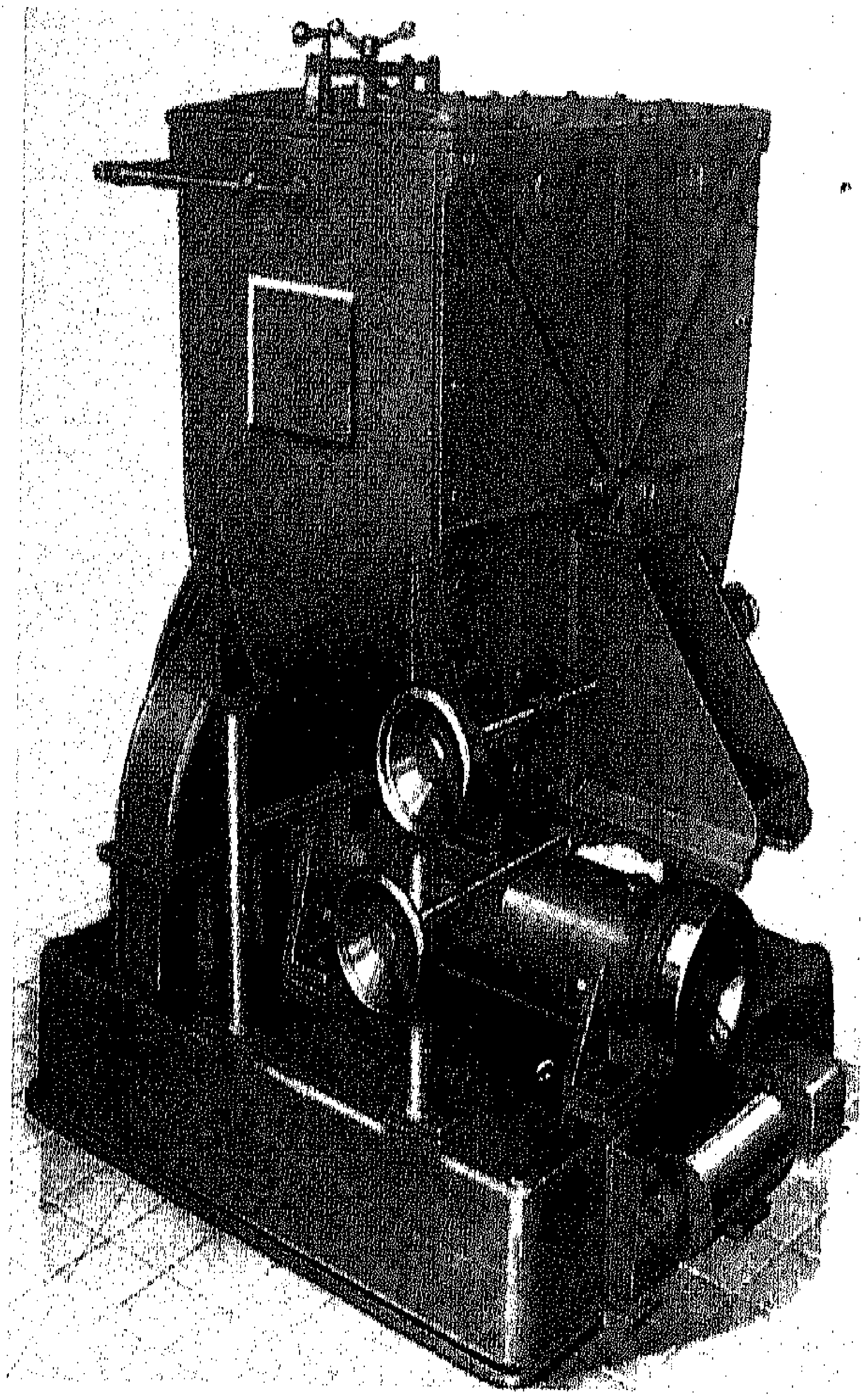


FIG. 27.—AASTED PLASTICATOR.

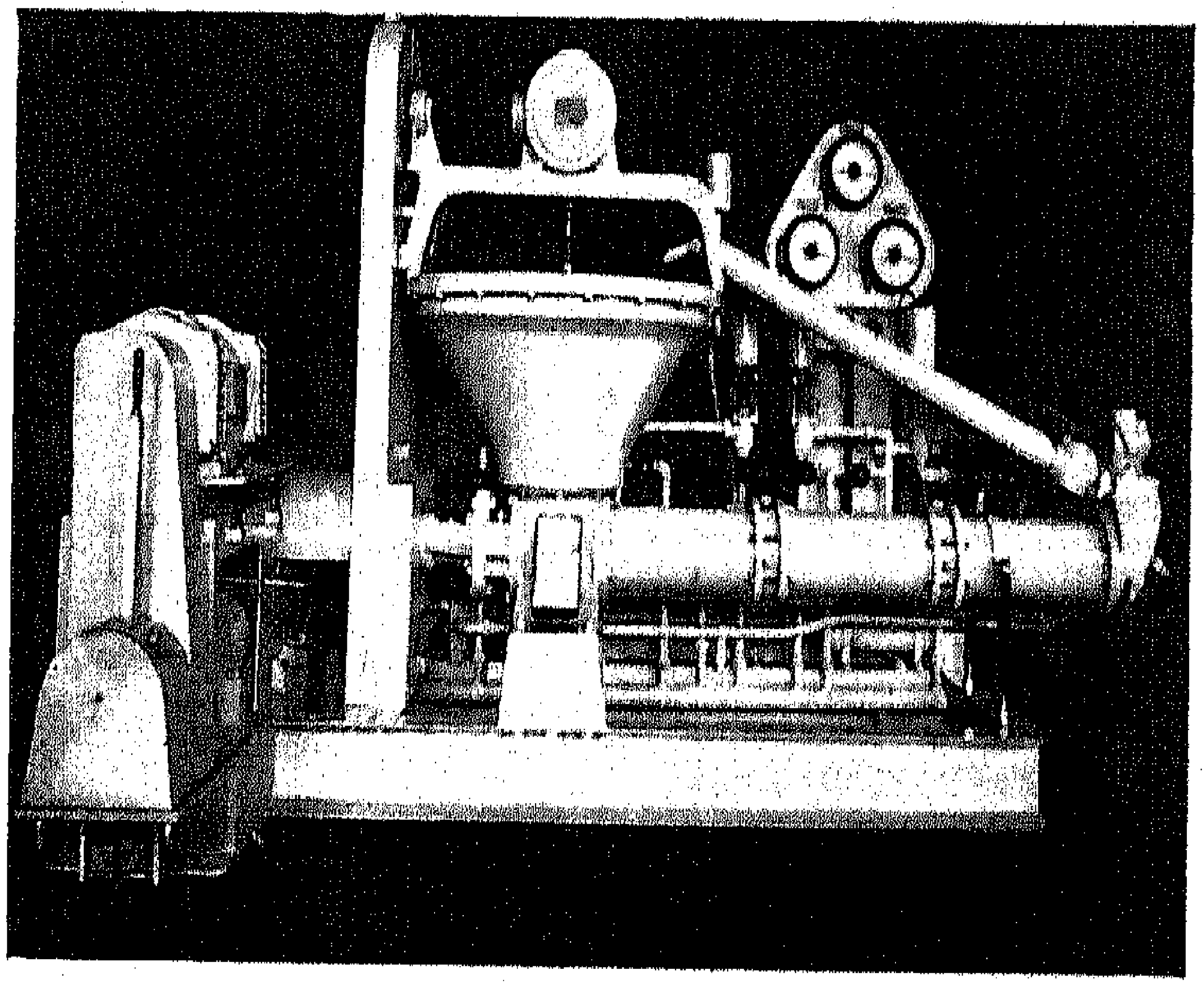


FIG. 28.—AUTOMATIC TEMPERING MACHINE.

in three removable longitudinal sections for rapid change. The agitation is provided by oblique rotating blades inside the sieve. The dressed starch is discharged at one outlet, whilst the foreign matter is separately delivered through a reject outlet.

Drying.—The dressed starch is then loaded into a Gardner Steam-Jacketed Dryer, in which an agitator brings all the particles of starch in repeated contact with the heated inner jacket. The dried starch is discharged through a slide outlet into suitable containers ready for re-use.

Drying Stoves

The modern confectionery drying stove consists fundamentally of a double-walled, insulated chamber through which a current of pre-heated, dehumidified air is forced by fan (Fig. 49). This air, having fulfilled its function of drying the goods, is naturally saturated, and is expelled from the exhaust end of the stove through adjustable louvres. Thence it passes by ducts through dehumidifiers and heating elements to be recirculated; this system results in heat conservation and economy of fuel. The temperature of the air is thermostatically controlled to suit the type of confection being processed. Drying efficiency depends on both the temperature and rate of extraction of saturated air.

Nougat Production

Nougat high-speed beating machines must be very strongly built to withstand the considerable strain placed on the blades by the heavy consistency of the nougat mass. The motion of the blades can be either differential or planetary in a steam-heated tilting pan of the vertical type. Alternatively, the nougat beater may take the form of a tilting horizontal cylinder with a central beater arm shaft. The top of the cylinder contains a charging and discharging aperture along its entire length fitted with a metal cover.

Owing to its peculiar consistency, nougat is cut by means of a vertical revolving knife. The Low and Duff model is fitted with an automatic traversing feed, operated by an eccentric plate constructed below the machine.

Marshmallow Beaters

The B.C.H. Marshmallow Beating Machine has a capacity of 200 lb. in 8-10 minutes. The machine has a horizontal shaft driving the beater arms at a speed of 150 r.p.m. fitted in a water-steam coil jacketed cylinder. The beaters and chamber are heavily tinned copper, which material ensures a long life under exacting conditions. Discharge of the mass is accomplished by tilting the machine.

Albumen Whisk.—The albumen whisk consists of vertical intersecting beater rods revolving in opposite directions in a removable cylindrical pan. The beaters are fitted with an elevating gear, and with scrapers in contact with the base of the pan. The important point to be remembered in connection with this machine is that all contacting parts must be constructed of non-corrosive metal, and must be kept scrupulously clean to prevent putrefaction (Fig. 50).

Toffee and Caramel Production

Several types of stirring pans are used for the production of toffees and caramels. There is the vertical mixer with differential action (Fig. 43) and automatic beater-elevating gear; the low type mixer in which the stirrers are swung clear of the pan to allow the latter to tilt, and finally, the Hansella under-driven boiling and mixing pans, which are becoming increasingly popular owing to their easy and efficient operation. These pans are of 200 lb. capacity and work under a steam pressure of 120 lb. per square inch. In any type of toffee boiling pan the most important factors to be considered are, efficient action of the attached scrapers, which prevent the mass being scorched on the sides of the pan, rapidity of tilting for discharge and ease of freeing the mixing blades of sugar mass, portions of which should not remain in the pan to re-cook.

The majority of toffees produced today are subject to manipulation by the plastic method, which reduces handling and thereby production costs. The toffee mass is cooled to the correct degree of plasticity, and placed in a vertical batch feeder. The batch is moulded by rollers to conical shape, and sizing wheels at the base of the machine form a rope which passes directly into a toffee cutting and wrapping machine.

Cutting Plant.—Manufacturers who prefer the rectangular shaped toffee piece use caramel brakes, the fluted rollers of which size the toffee sheets. The sheets are cut in pieces on a B.C.H. Compound Toffee and Caramel Cutting Machine (Fig. 45). This machine consists of two cutting heads, each fitted with a series of vertical, adjustable circular knives, under which cutting boards travel on an endless chain, the boards automatically turning at right angles between the cutting heads. In both methods, the toffee mass is taken from the boiling pans and tempered by pouring on water-cooled steel slabs fitted with removable steel containing bars.

Slab Toffee.—The production of subdivided toffee slabs of uniform weight is easily accomplished by means of toffee cutter frames. Using a standard 6 ft. by 3 ft. cooling plate (Fig. 44), a toffee mass of 60 lb. weight is poured on the oiled plate, levelled to a predetermined thickness by a B.C.H. Batch Leveller, and a set of four toffee cutter frames pressed firmly into the mass whilst still plastic. The construction of the cutters is such that the slab of the size required is cut completely through, whilst the subdivisions for easy breaking are scored partially through the mass. When the batch is cold, the frames are withdrawn and the toffee slabs separated and wrapped in heavily waxed paper.

Licorice Production

The production of licorice requires heavily built, steam-jacketed boiling pans fitted with stirrers and spring-actuated scrapers to boil the licorice mass. Standard steam tilting pans are adequate for the preparation of raw sugar solutions prior to filtering.

Refining.—From the pans, the cooked mass is transferred to a B.C.H. Licorice Paste Refiner. This machine presses the paste through fine mesh perforated plates to remove lumps so that no blockage occurs in the subsequent extruding process.

Extruding.—The refined paste is next fed into the hopper of an extruding machine. The hopper is fitted with stirrers to keep the mass in a thoroughly kneaded condition. The mass is forced through the dies in the die plate by variable speed feed worms. The extruded licorice in the form of hollow or solid rods, ribbons and sheets, either fluted or plain, passes on to a conveyor band carrying the receiving trays, which also has a variable-speed gear to synchronise with the rate of feed. The machine is designed to take either a plain head, which produces ribbons, sheets or rods, or a twist head forming twisted solid or hollow sticks. The capacity is 2½-4 cwt. per hour of hollow twisted sticks, 5-10 cwt. per hour of solid twisted sticks, and 7½-12½ cwt. of plain rods and sheets. The extruder may be used for forming coltsfoot rock.

Drying.—The extruded paste is taken from the machine conveyor on to strongly made tin-plate trays, which are transferred into well-designed, thermostatically controlled stoves maintained at a temperature of 130°-140°F.

Cutting.—Licorice goods and cream paste-licorice combinations are cut into pieces on vertical cutting machines, guillotine type. These all-purpose units are strongly built, and are designed with an adjustable pressure plate behind the cutting knife, the plate receiving an intermittent reciprocating motion from a crank and cam plate attached to the driving shaft. This action causes the plate to fall on the sheet of material to prevent movement whilst the knife is in action. The feed motion is variable, allowing quite a wide range of sizes to be cut on each machine. A modification of the cutter is produced to cut diamond-shaped pieces.

If satisfactory working is to be achieved, all machinery in the licorice department must be kept scrupulously clean and free from hardened paste.

Lozenge Production

The lozenge department is built around the main unit, which is the lozenge pinning, printing, embossing and cutting machine. This complicated machine is approximately 20 ft. by 5½ ft., and is capable of an output of 2½-3 tons per day (Fig. 47).

The gunmetal feed hopper at the head of the machine is charged with lozenge paste, whence it is forced under sizing rollers, which compress the mass into sheets of the required thickness and pass them on to a secondary conveyor. The sheet travels first under a printer bar carrying embossed dies or electro-type motto stamps which impress appropriate names or designs in the sheet of paste. The printed sheet then passes under the cutter bar, which cuts out the lozenges. The lozenges are ejected on to a travelling delivery plate, thence into trays, which are transferred to the drying rooms. The printing apparatus is simply thrown out of gear for the production of plain lozenges.

Cachou Cutting.—The B.C.H. Cachou Cutting Machine is a neat, efficient unit designed to cut thin sheets of gum paste into square or diamond-shaped pieces. A feature of the machine is a special cleaner plate, which is fitted between the circular knives to prevent the material rising from the fibre-board platen, whose speed is synchronised with that of the cutting knives.

Compressed Lozenges.—Compressed lozenges are produced at the rate of 100-150 per minute on the Worssam tablet press of the rotary or eccentric type. By means of a regulated helical worm feed, a constant level of material may be maintained in the feed hopper of this machine, and production of tablets rendered a continuous process.

Paste Mixing.—Lozenge and cream paste is produced in duplex mixing and kneading machines, which are U-shaped with horizontal mixing blades. These blades rotate at different speeds to ensure thorough mixing. If the paste is to be used for other purposes than lozenges, the manufactured paste is rolled out into sheets of the required thickness by clutch-operated reversible dough brakes.

Dragée Production

Goods under the generic title of dragées are produced in revolving pans, which are designed to keep the pieces or cores in rhythmic motion whilst receiving their successive coatings of sugar syrup. Dragée pans are made of single sheet heavy gauge copper, an outer shell being riveted to the main bowl, the annular cavity between the two forming the steam jacket. Variable speeds are necessary for different types of goods, and are obtained by three-speed cone drives. Smooth action is achieved by the use of friction coupling, which obviates undesirable vibration when starting or stopping the pan. The size of revolving pans usually ranges from 3 ft. to 5¼ ft. diameter, and

$1\frac{1}{2}$ ft. to $2\frac{1}{2}$ ft. in depth. Pans of the same design are used for the polishing and finishing of dragées (Fig. 46).

Air Ducts.—It is important that the steam supply to the dragée pans be capable of instant and finely controlled adjustment. A system of temperature and humidity controlled air ducts should be installed in the dragée department with small ducts leading off the main stem into each pan. This system assists very materially in producing highly finished goods by quickly removing the moisture-saturated air in direct contact with the mass.

Silver Dragées

Thick glass revolving pans on a very much smaller scale provide the means of producing dragées coated with silver or gold leaf. The glass bowls are fitted with hinged lids to prevent the expensive leaf escaping. This class of work requires a dry, temperate atmosphere for successful operation.

The dragée department is equipped with efficient drying stoves, capable of holding mobile racks for rapid handling. Syrups are prepared in conveniently placed steam-jacketed tilting pans, and chocolate liquor for coating centres is warmed and tempered in a standard chocolate tempering kettle.

Chewing Gum Production

Chewing gum ingredients are mixed in heavy duty, duplex, sigma-armed, steel mixing machines, the tough character of the mass necessitating powerful plant. From the mixer, appropriate charges of gum chicle paste are transferred to a specially designed thicknessing, forming and cutting machine. This B.C.H. machine consists of four pairs of fluted thicknessing rollers, and a cutting head containing two pairs of shaping rollers, which form and cut the gum sheet into the required shape and size (Fig. 51).

A $\frac{1}{2}$-in. thick gum paste sheet is fed to the first pair of thicknessing rollers, thence it passes progressively through the subsequent rollers until the required thickness of sheet arrives at the cutting head. In order to allow for the elastic character of the gum paste, the thicknessing rollers are set at varying centres

along the frame of the machine. For sugar-coated gum pieces, the cutting head rollers, which are $5\frac{1}{2}$ in. diameter solid steel, are grooved to produce the size and shape of gum pieces required, the ultimate roller being fitted with a floating pinion for alignment adjustment. The endless travelling band carrying the sheets is a woven cotton fabric 17 in. wide running over steel plates to provide rigidity and ensure long life to the band.

Adjustments.—It has been found that the usual method of roller adjustment by means of adjusting screws is not sufficiently accurate when dealing with chewing gum. In their place, steel gauges of varying thicknesses are fitted under the top caps of the roller-carrying housings, according to the thickness of sheet required. The housings are also supported by powerful springs to prevent damage to the rollers. Each set of thicknessing rollers is fitted with a felt-bottomed hopper carrying dusting powder, which is deposited on the travelling sheet of gum. When gum sticks are required, the first pair of cutting head rollers are grooved, but the second pair are machined flat and steel liners let in longitudinal slots.

Chocolate and Confectionery Wrapping Machines

The ever-increasing range of chocolate and confectionery wrapping machinery now available for every conceivable style and type of material is a tribute to the mechanical ingenuity of the technicians who created such machines. Wrapping machines are, of necessity, quite complicated pieces of mechanism, and need constant and knowledgeable attention to keep them operating at their stated capacity. Apart from the shelf-appeal value of candies wrapped in highly decorative foils and papers, the hygienic and protective value of wrapping media is of paramount importance.

Hard Sugar Moulding and Wrapping.—An interesting machine, which is a combination of plastic moulder and wrapping unit, is the "Forsella" Plasrap Machine. This takes the cooled moulded hard goods from the moulding mechanism, separates the pieces by reciprocating plunger and twist-wraps each sweet at the rate of 500 per minute. It is designed to accommodate either waxed paper or cellulose film, and the moulding unit will handle either solid goods or those filled with sherbet, jam and chocolate centres.

Twist Wrapping.—The Forgrove 42C Plastic Toffee Wrapping Machine is directly connected to a vertical batch feeder. The machine takes the rope of toffee, cuts it, and twist-wraps each piece at the rate of 600 per minute. The Forgrove 42B Plastic Cutting and Wrapping Machine performs the same function, but fold-wraps each piece at the rate of 500 per minute. The machine is constructed to deliver the wrapped toffees side by side with the folds underneath. This action facilitates packing. If the wrapping medium is printed to show the design on top of the pieces, a mechanical registration device is incorporated to ensure correct alignment.

Wrapping Irregular Shapes.—A wide range of machines has been evolved for the wrapping of irregular shapes of chocolates and other confectionery. The Lauenstein Universal Wrapping Machine is an excellent example of such a machine (Fig. 52). It is fitted with adjustable sponge-rubber grippers, which hold the piece so that no crushing or damage can occur. In common with all universal wrapping machines, it is hand-fed, each piece being placed in slots in a feed-plate, working at the rate of 85 pieces per minute. The Lauenstein can fold-wrap irregular pieces in aluminium or tin foil, waxed paper and cellulose film, and is fitted with a heat-sealing device. It will wrap assorted chocolates and Easter eggs up to $1\frac{5}{16}$ in.; Neapolitans and bar goods to $3\frac{1}{8}$ by $1\frac{1}{2}$ in. and $3\frac{1}{2}$ by $\frac{5}{8}$ in. The smallest possible size of piece the machine will take is $\frac{7}{16}$ in. square by $\frac{3}{8}$ in. high. A banding attachment and registering device are fitted so that the goods may be foiled and banded consecutively correctly aligned. The machine has an automatic locking device to prevent feeding foil and bands when there is no piece in the feeding slot, a feature common to all types of universal wrapping machines.

Crimp and Sachet Wrapping.—The Forgrove 22B Universal Wrapping Machine was introduced to twist-wrap irregular-shaped delicate chocolates and confectionery. By means of interchangeable parts, a wide range of shapes and sizes can be wrapped, and interchangeable wrapping mechanisms allow special wraps, such as the crimp and sachet types. Although the range of functions of this machine has been increased, the

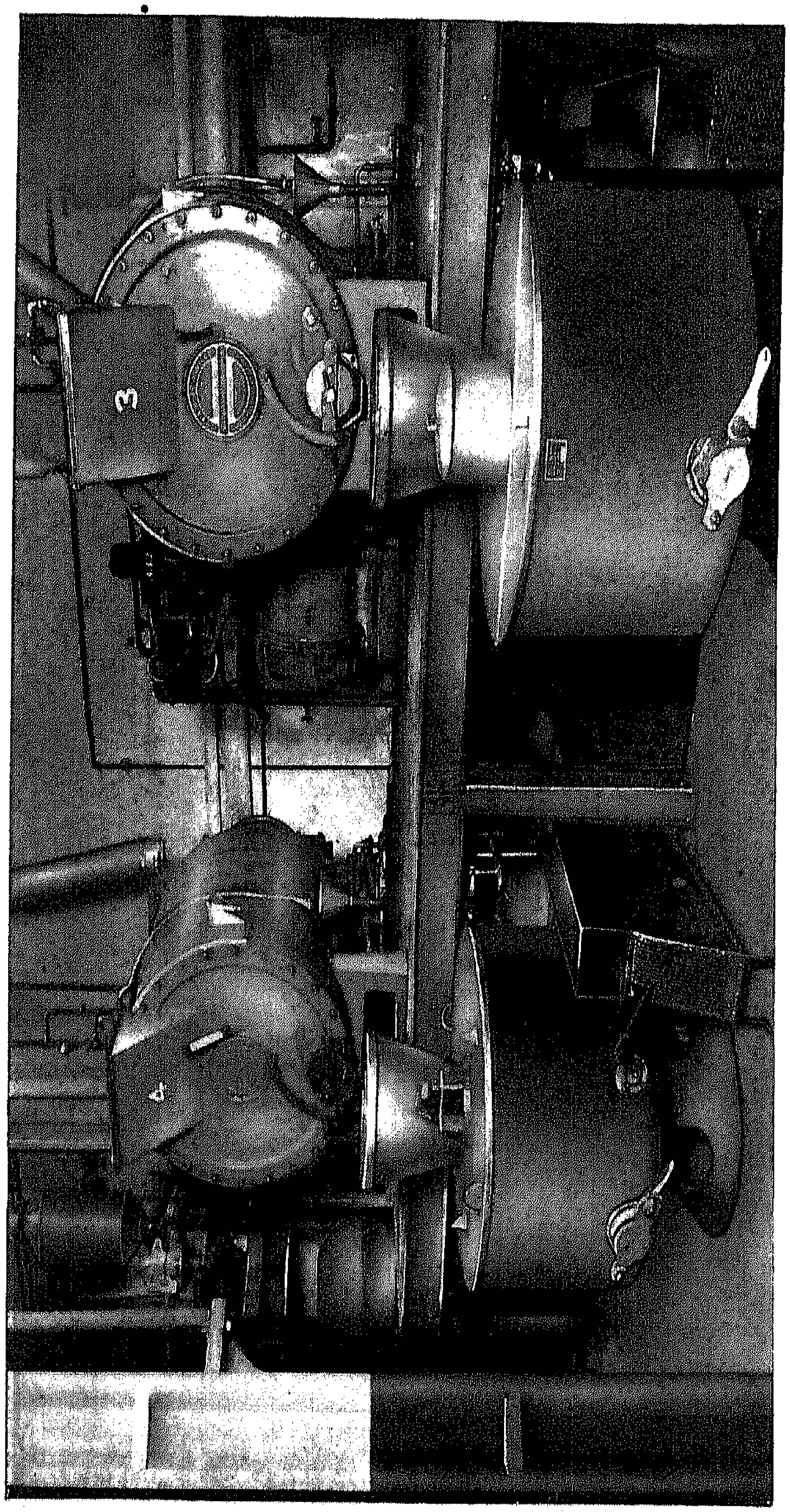


Fig. 29.—McIntyre Chocolate Machines.

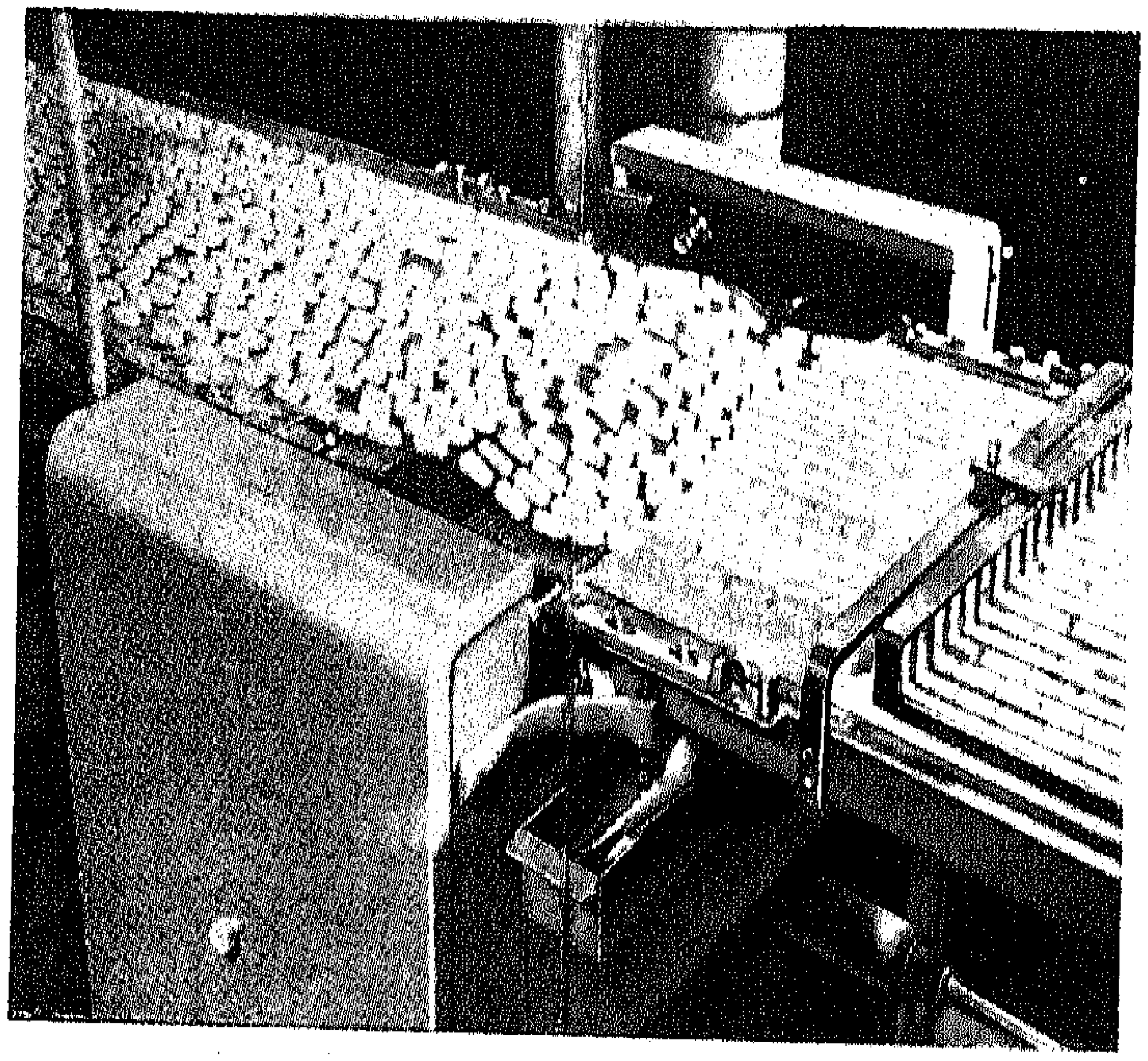


FIG. 30.—GREER PRE-BOTTOMER.

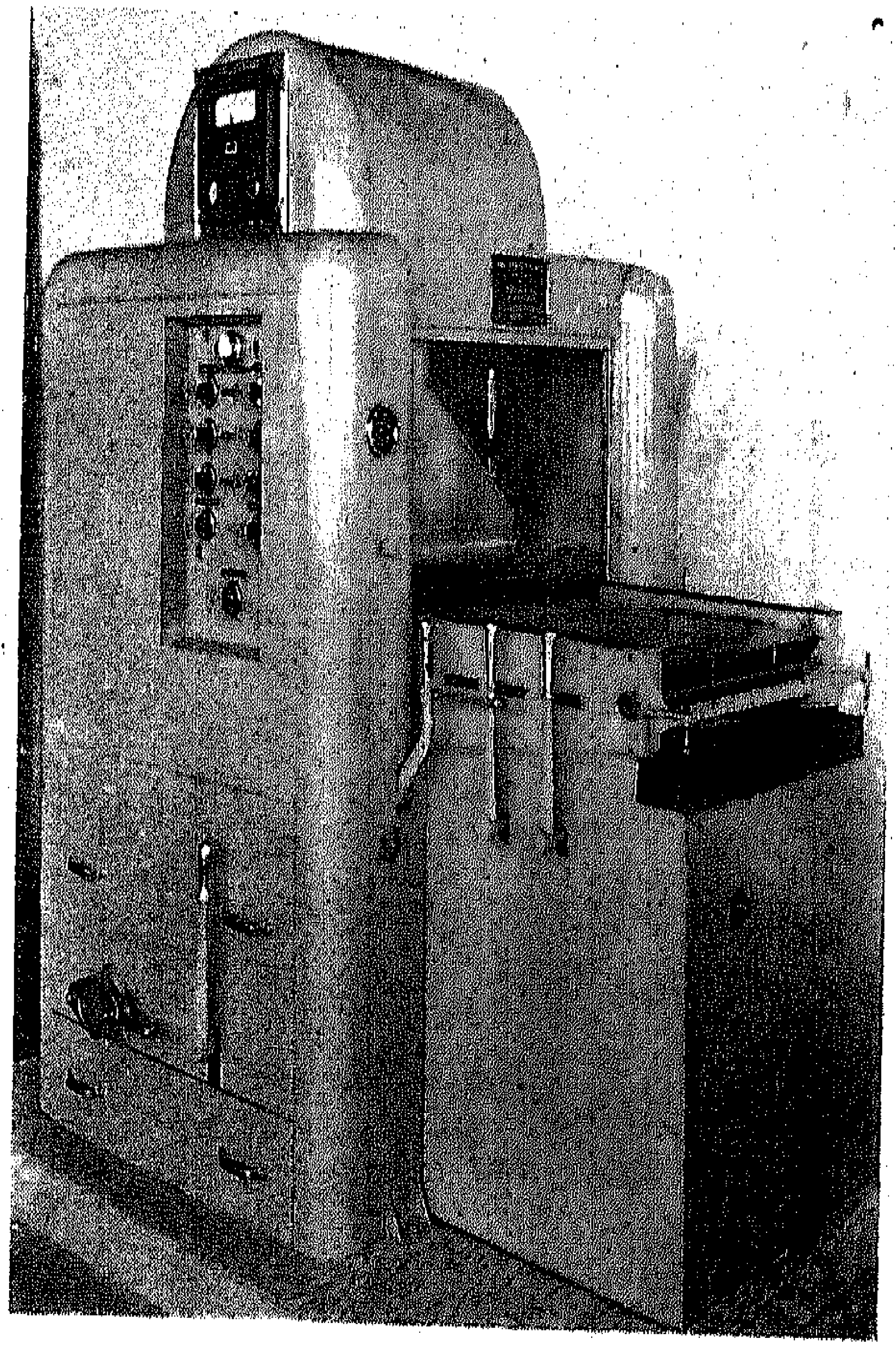


FIG. 31.—THE GREER CHOCOLATE ENROBER.
(Note streamlined construction.)

design has been modified to simplify operation and maintenance. A trip gear attachment allows a cut wrapper to come forward only when a piece is in position to receive it, an important point in any wrapping machine. This unit accommodates double wrappings or understrips, and is fitted with a registration gear for positional control of printed designs. Waxed paper, cellulose film or waxed-backed foil may be used. The speed of the machine is 160 pieces per minute. The maximum size of piece possible is $2\frac{3}{8}$ in. by $3\frac{3}{8}$ in. by $\frac{7}{8}$ in.; the minimum, $\frac{5}{8}$in. by $\frac{1}{4}$ in. by $\frac{1}{8}$ in.

Bar Foiling and Banding.—The Forgrove 55 Chocolate Bar Foiling and Banding Machine, as the description implies, fold-wraps chocolate bars or cakes in waxed paper, foil or cellulose film, and applies an outer printed wrapper consecutively. The outer wrapper may be pre-cut to size and automatically fed from a feed-stack, or in coil form. In the latter case, positional control is effected by a photo-electric cell attachment, which depends on the density of tone reflection from the printed wrapper for its functioning. The incorporation of an ingenious device to present the foil at an angle to the tablet engenders a saving of foil. The speed of the machine is 90 tablets per minute, and the sizes of tablets range from $3\frac{1}{4}$ in. by $1\frac{1}{2}$in. by $\frac{1}{4}$ in. to $4\frac{1}{2}$ in. by $2\frac{1}{2}$ in. by $\frac{3}{4}$ in. (Fig. 53).

Liqueur Wrapping.—An excellent machine for the foil-wrapping of specially moulded chocolate shapes filled with liqueur centres is the Sapal Type PV. The individual pieces are placed in a feed disc in appropriately designed slots, foil is taken from a roll and carefully folded around the piece, together with an outer band if required. The machine is fitted with an automatic mechanical or photo-electric cell registering device for printed foils. The speed of the Sapal foiler is 80 pieces per minute (Fig. 54).

Roll Wrapping.—The Forgrove 57 Roll Wrapping Machine is worked in series with a tablet assembler and feeder unit. Compressed lozenges or seamless hard sugar goods of uniform size are placed in the feeder tray, whence they are automatically fed into channelled chutes, which form a series of rolls of equal length. These rolls are twist- or fold-wrapped in foil, cellulose film or waxed paper, and an outer printed wrapper applied in the form of a gummed band. The wrapped rolls are delivered to an inclined conveyor belt over which an adjustable metal plate is fixed, so that the rolls are subjected to a rolling and smoothing action to tighten the wrap. The capacity of the machine is 80 rolls per minute, and the range of sizes of rolls is 3 in. by $\frac{1}{2}$ in. to 6 in. by $1\frac{1}{8}$ in.

Automatic Weighing and Filling

Automatic weighing machines and combined weighing and packing machines are essential items of equipment in all chocolate, cocoa and confectionery factories. Intermediate processes often involve a weighing operation, and the weighing machine should be designed to maintain the continuity engendered by modern production methods to eliminate, where possible, all manual handling.

Powder Weighing and Filling.—The Southall and Smith Automatic Weighing and Filling Machine is used for the weighing and filling of powders, such as cocoa and similar materials, and modifications of the machine cover the whole range of diverse weighing operations encountered in production. Once the powder, crystal or granulated material has been gravity-fed into the feed-hopper of the machine the weighing is done automatically, and the weighed amount of material is ejected through a nozzle into bags or cartons placed at the outlet by an operator. The output of the single beam automatic weighing machine is 16-20 packets per minute.

Sugar Pulverising

There are many types of machines in use for the purpose of pulverising sugar for chocolate and confectionery manufacture. Outstanding examples of modern mills are the American Mikro-Pulveriser and Mikro-Atomiser, and the British Kek Mill.

The Mikro-Pulveriser will grind sugar to 325 mesh (44 microns), and the Mikro-Atomiser produces powders from 25 down to 2 microns (Fig. 55).

Operation.—The basic principle employed in the Mikro-Pulveriser is essentially the use of impact force. Feed screws convey the raw material to the periphery of the rotor at the point of highest impact. Thus granulated sugar is tipped into the boot of a bucket elevator, which carries the sugar to a screw conveyor discharging into the hopper of the pulveriser. Here the sugar is taken up by a feed screw to be fed into the mill, where it is subjected to the enormous impact of swinging hammers fixed to a rotor revolving at high speed. Thence the pulverised sugar falls into a receiving hopper, from which it is discharged into containers by screw conveyor. Tolerances in the Mikro-Pulveriser are within very close limits, an important factor when the pulverised sugar is used in the manufacture of chocolate, when subsequent refining processes are materially assisted by the initial fineness of the constituent ingredients. Furthermore, the machine being entirely mechanical in operation, using neither fans nor other separating devices, reduces dust, which is a visible indication of lost material, to an absolute minimum.

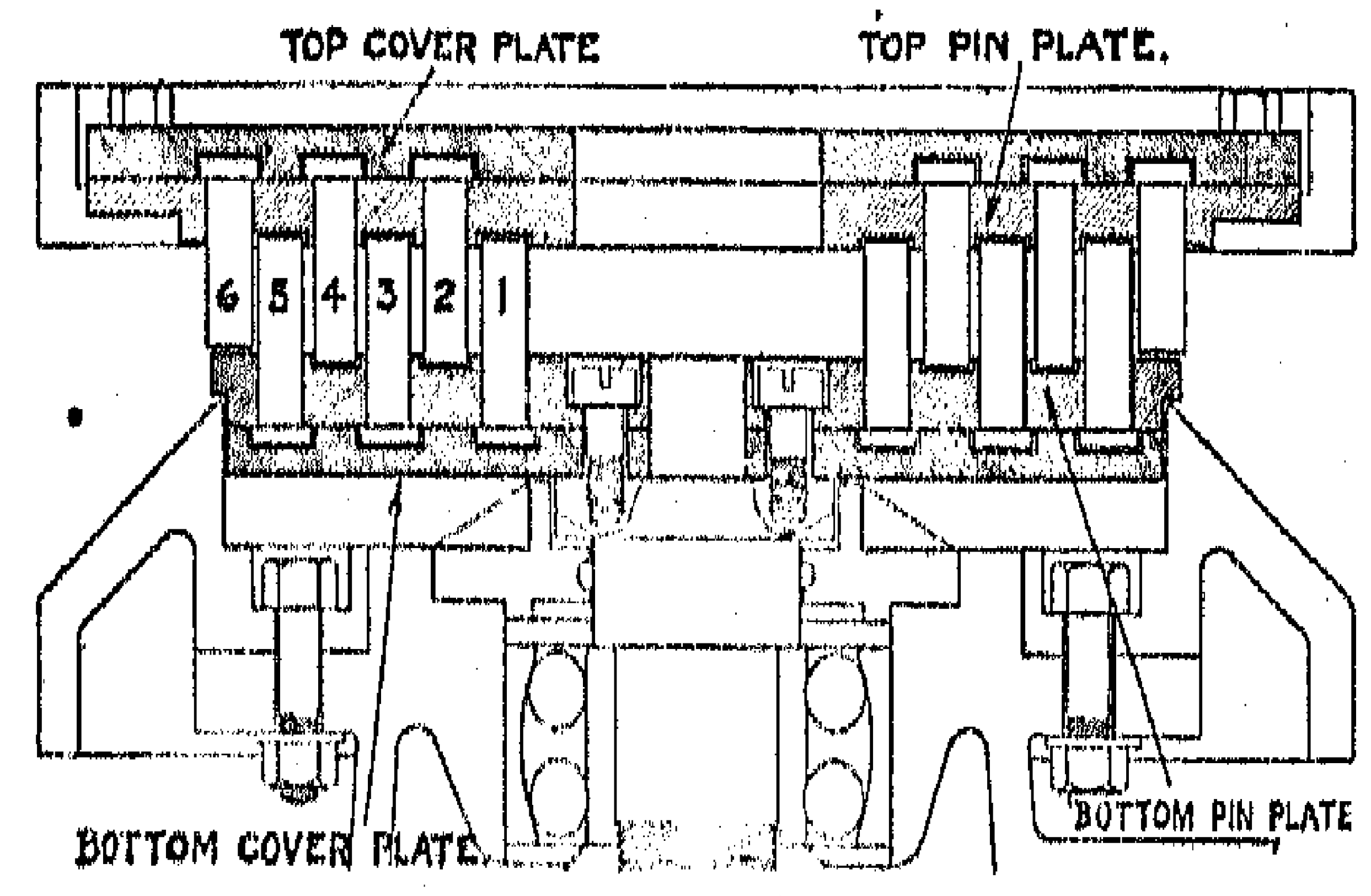


FIG. 32.—KEK MILL.

Pin Disc Milling.—The Kek Mill is of the pin disc type and depends on the principle of horizontal high-speed centrifugal action. It consists essentially of two circular metal discs studded with strong metal pins set in concentric circles openly spaced near the centre, but progressively closing in formation towards the perimeter (Fig. 32). The lower plate revolves at high speed and is vibrationless. The upper plate is stationary and the pins which point downward fit into the spaces between the circles of pins in the lower plate. The material is fed through a central hole in the upper plate. As the material contacts the revolving lower plate, it is flung against the pins by centrifugal force, and is crushed progressively finer as it is forced through the decreasing clearances of the outer pins to the periphery. The absence of screens and grids eliminates clogging, whilst the constant circulation of air engendered by the fanning action of the revolving pins maintains a cool and aerated condition in the material. To achieve continuity of operation, the Kek Mill is fitted with an adequate hopper fitted with a shaker feeder, which maintains a uniform flow of material into the mill. The hopper may be gravity fed or charged by means of a screw conveyor. The stream of material from the hopper passes through a magnetic chute before entering the mill, to remove any metallic bodies which might possibly enter the material. Dust is reduced to a minimum as in the case of the Mikro-Pulveriser, which is one of the greatest advantages of these modern mills. The capacity of the Kek Mill No. 1 is 1,680 lb.-3,360 lb. per hour. Mikro-pulverisers are built in various sizes capable of producing from 75 to 6,500 lb. per hour.

Plant Development.—In conclusion, the essential fact to remember is that plant development does not stand still, and it is in the best interests of the confectionery manufacturer to keep in close touch with the plant manufacturer so that the latest types of machines are installed in factories when replacement becomes necessary. The Bramigk organisation is at present engaged on important development of a new type of chocolate refiner, automatic tempering machine, a greatly improved type Mogul plant for starch work, starch tray loaders and starch conditioning plant. It is also actively studying an improved cocoa powder plant of continental design and a new continuous chocolate mixer which may take the place of the standard melangeur. The Baker-Perkins group are perfecting a new type of chocolate conche and other machines. The Brierley, Collier and Hartley organisation has an interesting plant development programme with a strong tendency toward the simplification and streamlining of machines.

This very brief survey of development plans shows that the machines of the future will present a vastly different aspect and increased efficiency compared with past design.

This fact is amply confirmed by study of the latest results of many interesting European and American machinery designs now being made available to the industry.

CHAPTER VII

HARD SUGAR GOODS

The Functions of "Doctors"

HARD candies are either a simple combination of sucrose and corn syrup or sucrose alone treated with an acid doctor, such as cream of tartar (potassium acid tartrate). Doctors are chemicals which are added to sugar mixtures to prevent crystallisation of the saturated sugar solution. There are two types of doctor: one hydrolises a portion of the sucrose to form invert sugar, and the other retards the rate of crystallisation; cream of tartar belongs to the former type, corn syrup and manufactured invert sugar to the latter.

The production of all-sugar goods using cream of tartar as the doctor allows no margin of error to the operator. The sugar used must be impurity-free so that no counteraction occurs in the doctor. Whilst modern methods of sugar production result in the highest possible degree of purity, unsatisfactory storage conditions might cause the sugar to absorb impurities.

Cooking conditions and amounts of added doctor must be rigidly standardised; deviation from such standards produces either a grained or sticky candy. Under-inversion gives rise to the former condition, and over-inversion to the latter.

Although there is an inevitable reduction in the sweetness of a hard candy by the addition of corn syrup, this is the method more generally used, since control is simplified. Careful control of proportions of raw material is obviously still essential; guesswork by an operator, however skilled he may be, has no place in modern practice.

Hard candies may be made from formulæ using from 25 to 50 per cent. corn syrup, the amount depending on cost requirements and sweetness desired. The higher the percentage of corn syrup, the greater the tendency of the goods to absorb moisture (Fig. 56).

Finally, the packaging of hard candies must be efficient. If the goods are unwrapped, atmospheric moisture, which enters the container each time the lid is removed, must be absorbed by hygroscopic pads fitted in the lids: pads capable of periodic baking to maintain their absorption efficiency. Hard candies which have been lightly steamed and sugared offer greater resistance to unfavourable atmospheric conditions, but should not be left uncovered for prolonged periods.

The trend today is toward fully wrapped candies. Wrapping, properly executed, excludes outside moisture, but will offer no protection to a candy carelessly produced. A consumer is justifiably annoyed if he receives a wrapped candy in a state of hydrotropic collapse, or disappointing granulation.

Under close control, hard candies lend themselves admirably to mass production, and the modern plant available for continuous operation has reached a very high degree of mechanical efficiency.

Formulæ

Almond Hardbake (Gas Cooker)

Tate's Grade 20 pieces	15 lb.
Granulated sugar	20 lb.
Cream of tartar	1¾ oz.
Split sweet almonds	7 lb.
Water	1¼ gal.

The almonds are fairly evenly spread over a well-oiled cooling slab fitted with enclosing steel bars.

The sugar is placed in 1¼ gal. of water in the boiling pan. This is heated and stirred well until a perfect solution is obtained. The surface should be skimmed, the cream of tartar added, and the batch cooked to 295°F. The batch is poured over the almonds on the slab to a predetermined thickness, and whilst the batch is still plastic, it is marked with cutters into blocks. The pieces are divided when cold and wrapped in heavy waxed paper.

Clear Mints (Cream of tartar)

Best white sugar	28 lb.
Cream of tartar	1 oz.
Water	1 gal.
Peppermint oil	1 fl. oz.

The sugar is dissolved in the water carefully, and the surface skimmed of any froth. Cream of tartar is added with a few drops of blue colour to enhance the final brightness, and the batch cooked to 305°F. The peppermint oil is added, and the mass poured out in a frame laid on an oiled cooling slab, and when cooled somewhat, another frame is pressed firmly on the surface, so marking it sufficiently deeply to allow the pieces to be easily parted when cold. The pieces are packed into containers, or wrapped in waxed paper immediately.

Fruit Drops, Lemon (Vacuum cooked)

Granulated sugar	112 lb.
Corn syrup	56 lb.
Citric or tartaric acid	1½ lb.
Oil of lemon	1 fl. oz.

The sugar and corn syrup are carefully dissolved in the syruping pan in sufficient water to give a syrup of 36° Baumé density. The syrup is passed through the continuous cooker and cooked to 295°F. Proportionate amounts of acid and flavour are incorporated into the portions of the batch as they are transferred to the cooling slab, and passed through the Rostoplast machine, or other moulding machines, as available.

For lettered rock or other pulled hard candies, the batch is cooked to 285°F.

Barley Sugar Sticks

Granulated sugar	24 lb.
Corn syrup	6 lb.
Oil of lemon	¼ fl. oz.

The sugar and corn syrup are dissolved in water to form a 36° Baumé syrup and cooked to 295°F. either by open stove, vacuum cooker or atmospheric continuous cooker. The oil of lemon and colour are mixed into the batch on the slab, the mass being cut in strips, flattened, twisted and passed to a cooled slab, where an assistant continues rolling to maintain shape until quite hard. The twisted lengths are cut into appropriate lengths and wrapped in cellulose film or waxed paper.

Buttered Almonds

Granulated sugar	24 lb.
Corn syrup	12 lb.
Butter	1½ lb.

The sugar and corn syrup are dissolved in water and cooked to 305°F. Heating is discontinued and the butter carefully added and stirred slowly. The batch is transferred to heated dipping pots. The centres to be dipped are thrown a few at a time into the pot and retrieved by means of a dipping spoon, and placed on oiled metal plaques. The dipping must be carried out rapidly, so that the prolonged heating of the mass does not darken the colour.

When set, the goods are packed in well-sealed containers or wrapped in waxed paper as quickly as possible.

The general lay-out for the production of this type of confection must be planned to eliminate unnecessary motion and manipulation. Excessive agitation stimulates granulation and can be avoided by the careful training of the operatives concerned. All equipment must be maintained in a spotlessly clean condition and the pots thoroughly cleansed after use. Granulation is bound to take place if charge after charge is poured on previous portions left in the dipping pot.

Waste buttered goods are soaked to retrieve the nuts for drying and re-use, and the syrup used in the starch department for the production of dark pastilles, as described in Chapter XIV.

Butterscotch

Tate's Grade 20 pieces	24 lb.
Corn syrup	6 lb.
Salt butter	1 lb.
Oil of lemon	¼ fl. oz.
Water	1 gal.

The sugar and corn syrup are dissolved completely in 1 gal. of water in a boiling pan and cooked to 290°F. The heat is withdrawn and butter added, mixed, and oil of lemon added. The batch is transferred to frames on oiled cooling slabs and impressed with a frame cutter whilst still plastic. The pieces

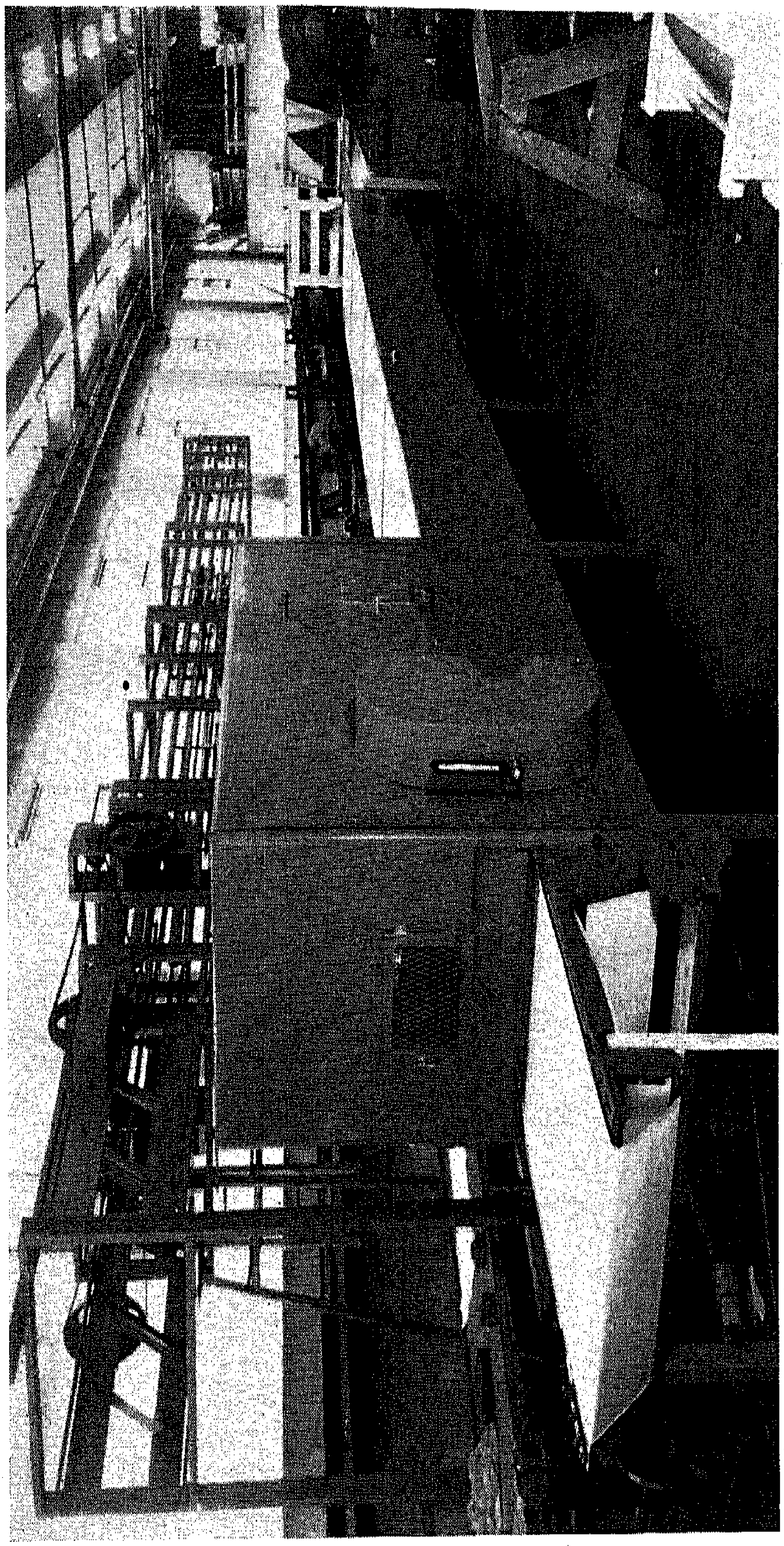


FIG. 33.—GREER HI-GLOSS COOLING TUNNEL.

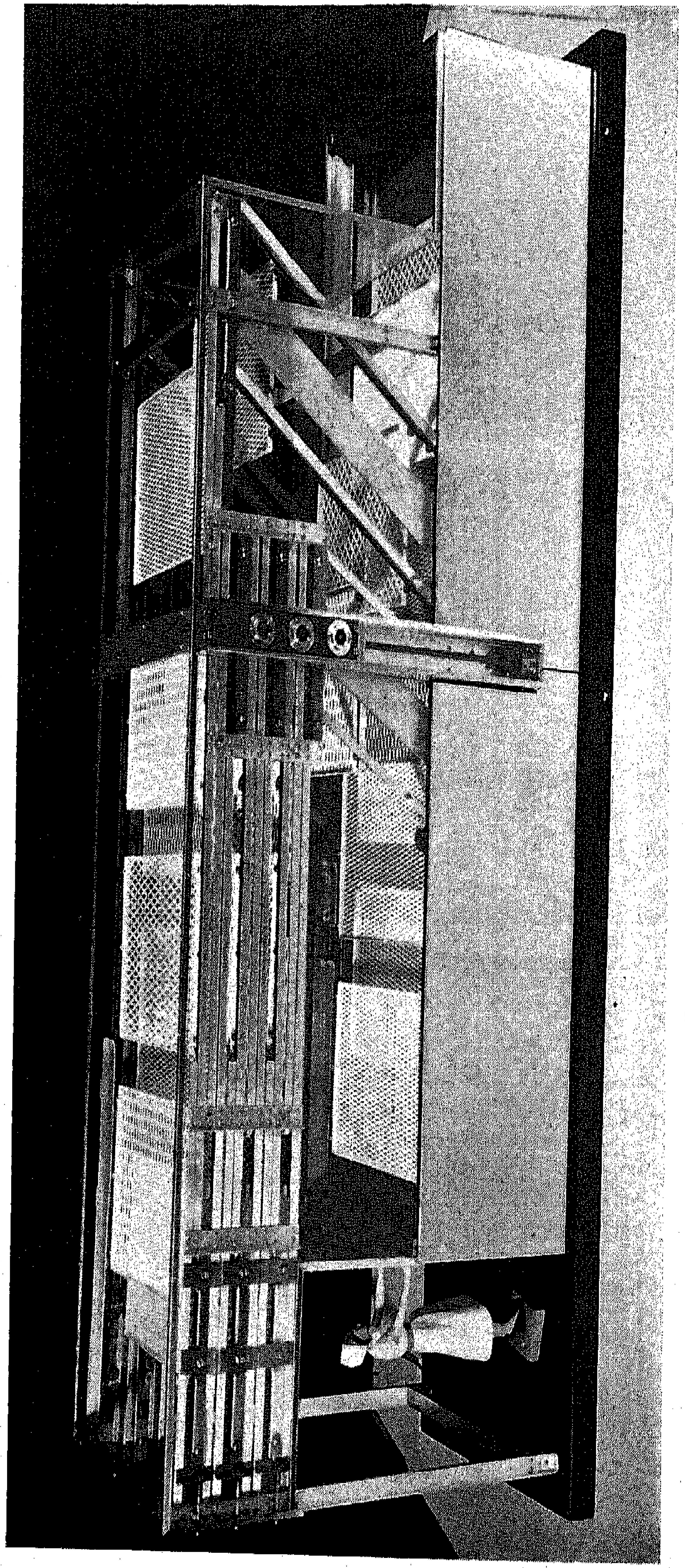


FIG. 34.—GREER MULTI-TIER COOLER.

are divided when cold and wrapped immediately in waxed paper or wax-backed foil.

Jam for Soft-centred Plastics

Sieved apple pulp	70 lb.
Granulated sugar	112 lb.
Citric acid	2 oz.
Water	2 gal.

The sugar is dissolved in the water and the apple pulp and citric acid added. The batch is cooked to 230°F., cooled and transferred to the hopper of soft-centre feeding machine attached to the batch roller, and forced into the centre of the batch.

When high-temperature (310°F.) batches, such as satin work, are being manipulated on a heated plate, a soft leather sheet spread over the plate will prevent melting of the batch in contact with the hot surface.

Satin Pralines

Casing:

White sugar	28 lb.
Cream of tartar	1 oz.
Water	1 gal.
Fruit essence	½ fl. oz.

The sugar and cream of tartar are dissolved in the water, cooked to 310°F., and poured on a lightly oiled slab to cool. The flavour is added and the batch coloured delicately. When the batch has reached the right degree of plasticity, it is pulled sufficiently to make it appear somewhat translucent; excessive pulling will spoil the effect. It is returned to the hot slab, kneaded, and the batch spread to a sheet. The praline paste is placed on the sheet, and the ends of the latter folded over the paste to form a complete casing. The centre must be quite warm to prevent cracking in the casing, and as dry as possible to obviate leaking. The whole batch is placed in a heated batch roller, and passed through appropriate die machines, cooled and packed immediately into containers.

CHAPTER VIII

CHOCOLATE

ALTHOUGH there are a number of variations of the accepted methods of chocolate manufacture, the differences lie chiefly in the type of plant used. Standard of quality, degree of fineness, and financial considerations govern the extent of the plant to be installed. The very small manufacturer who desires to use a smooth, well-produced chocolate for coating his own centres finds it expedient to purchase such chocolate from a reputable house, and give his customers a satisfactorily finished product. The medium-size manufacturer might be content to end his process at the refiner stage, omitting the final refinement of conching. By this means the capacity of the available plant is increased, but the chocolate produced is not in the top flight, and is somewhat harsh to the palate. Finally, the large-scale manufacturer, who is concerned only with the highest possible quality in the matter of ingredients and palatability, together with maximum efficiency of production, installs the most modern plant, which, together with scientific methods of control and improved methods of manipulation, ensures that his products have received the maximum refinement that such plant can give him.

There is no substitution for continuous attention to every detail of the many processes through which chocolate passes from the selection of the appropriate beans to the packaged merchandise. Science has evolved many instruments which, intelligently used, render process control comparatively easy, and there is no excuse other than negligence for shoddy workmanship and imperfect products.

Cacao Beans

The first step in production is selection of the cacao beans which are to produce the type of chocolate required. On proper selectivity and blending depends much of the final

flavour of the chocolate. Cacao beans may be divided into two categories of flavour intensity, as below:

طعم قوي

Strong Varieties.

St. Lucia
Para
Accra
St. Domingo
St. Vincent
Bahias
St. Thomé
Demerara
Surinam
Cayenne
Tobago
Cuba
Dominica
Trinidad
Grenada

طعم معتدل [illegible]

Mild Varieties.

Ceylon
Mauritius
Madagascar
Peruvian
Arriba
Caracas
Java
Puerto Cabello
Seychelles
Madras
Jamaica
Columbia

There are two distinct species of cacao bean, Criollo and Forestero; the latter is subdivided into Angoleta, Cundeamor, Amelonado and Calabacillo varieties. Intensive plant biological research and study have been, and are still being, devoted to the evolution and cultivation of varieties of cacao trees to produce hybrid species resistant to the diseases peculiar to the plant. The planters are alive to the fact that cacao is a product of the highest importance in the world's economy, and are determined that propagation of the species shall not be interrupted by the incidence of disease, which is, unfortunately, still prevalent in the form of club-root in West Africa.

Treatment of Beans.—The cacao tree is a very delicate plant, and needs protection from the sun and wind; this protection is provided by the planting of prolific banana trees and nitrogen-collecting shade trees adjacent to the cacao trees. When the beans are extracted from the pods (Fig. 57), they are covered with a thick sweet pulp, which is removed by fermentation carried out in large wooden bins with perforated bottoms for draining the fermented liquor. A considerable amount of heat is generated during the process, and the beans are stirred at intervals to release some of the heat and ensure a uniform degree of ferment throughout the mass. The period of fermentation covers 7-12 days, according to the quality of bean required; the colour, flavour and texture of the bean is largely dependent on the fermentation process, hence the importance of this step in the preparation of the cacao bean for the market. The beans are dried as soon as the generated heat in the beans has fallen to a certain temperature, bagged and shipped.

Although more than 50 per cent. of the world's usage is derived from cacao beans of the Forestero species grown in West Africa, the quality of the African bean is inferior to that of the Criollo and Criollo-Forestero cacaos. When the same intensive study which has been applied to West Indian and South American plants is devoted to the West African variety, gradual evolution of an improved species will result (Fig. 58).

Flavour of Beans.—Knowledge of the characteristic flavours imparted by the various beans is acquired by experience of practical tests of the final flavour of the chocolate produced from each type. A chocolate produced entirely from Accra beans has a very strong, harsh flavour, whereas that in which Caracas beans have been used results in a mildly flavoured but very pleasing product. It is for the chocolatier to determine the proportion of strong and mild cacao beans necessary to produce a blend that will result in a satisfying chocolate. There are subtle shades of flavour differentiation in each type of beans, and variations of final flavour are obtained by blending two, three or more types of bean after roasting. For instance, a blend of 42 per cent. Trinidad (strong), 21 per cent. Para or Accra (strong), and 37 per cent. Caracas (mild) beans produces an excellent chocolate. The facts of availability of supplies and the costs of beans are purposely ignored, as the chief consideration is the study of chocolate production in the complete sense.

Cleaning and Grading.—As the beans often arrive at the factory with a considerable admixture of foreign matter, such as clay, dust, stones and possibly pieces of metal, they are subjected to a cleaning and grading process. This is carried out in the cleaning and grading machine. The operators carefully inspect the issuing beans, which are collected either in containers for sirocco-type roasters or transferred to band conveyors to feed continuous roasters.

Roasting.—The degree of roasting is extremely important, since over-roasting destroys the natural flavour of the bean and produces a bitter product, whilst under-roasting does not eradicate the bitterness of the raw bean and renders the removal of the husk more difficult. The reasons for roasting cacao beans are (1) to develop the aroma, (2) enrich the colour, (3) render starch granules soluble, (4) chemically change phlobatannin content, (5) dry the husk to facilitate its removal, (6) dehydrate the bean for grinding.

Different types of beans require variations in roasting temperatures, according to their texture; the mild varieties are usually roasted at lower temperatures than the strong types. Roasting temperatures vary from approximately 260°F. to 295°F. After roasting, the beans are cooled as quickly as possible to prevent further internal roasting, and are passed into a husking and winnowing machine, which cracks the bean, separates the nib from the husks and any remaining foreign matter, and extracts the germ of the bean.

Blending.—The next stage is blending. Appropriate quantities of two or more kinds of cacao nibs are weighed, according to formula, and placed in a cylindrical blender which thoroughly mixes the nibs before they are gravity fed to the grinding mills.

Grinding.—These liquor mills are water-cooled to keep the mass at a low temperature to retain the flavour. The liquor flows out of the mill into shallow metal containers.

Mixing.—At this point, it is ready for admixture with finely powdered sugar and added cacao butter in the melangeur or horizontal blade mixers, in which machines the mass remains until it is thoroughly mixed. In the case of milk chocolate, milk powder or evaporated sweetened milk is added to the mass in the mixer. The mass when discharged from the mixer should resemble a well-kneaded dough. The cacao butter content of the liquor, which ranges from 52 to 54 per cent., with a very small addition of butter will suffice to bring about this condition. At this stage, the milk chocolate mass may be transferred to a vacuum drying plant to reduce the fairly high moisture content.

Refining.—The chocolate mass is fed into the hopper of the of fat fractions of differing melting points. Tempering is essentially a process of creating a finely balanced crystalline state of the fats throughout the chocolate mass, so that on refrigeration the fat crystals adequately coat the particles of solid cocoa. If tempering has been imperfectly carried out, the fat fractions separate out on refrigeration and give rise to fat bloom on the surface of the chocolate.

An interesting problem arises when the rate of tempering is increased in automatic tempering machines. Fig. 35 shows a graphic example of a curve illustrating progressive temperature conditions in a chocolate under treatment. In the first and second phases, which are essentially cooling operations, an increased rate of cooling would cause incomplete crystallisation of the constituent fat fractions of the cacao butter if the minimum temperature were the same as that for low-speed tempering. The final phase of raising the temperature of the chocolate would, under the same conditions, be too rapid to cause even and complete restoration. A lower minimum temperature is therefore necessary as the rate of tempering increases; the difference between the minimum temperature and the final

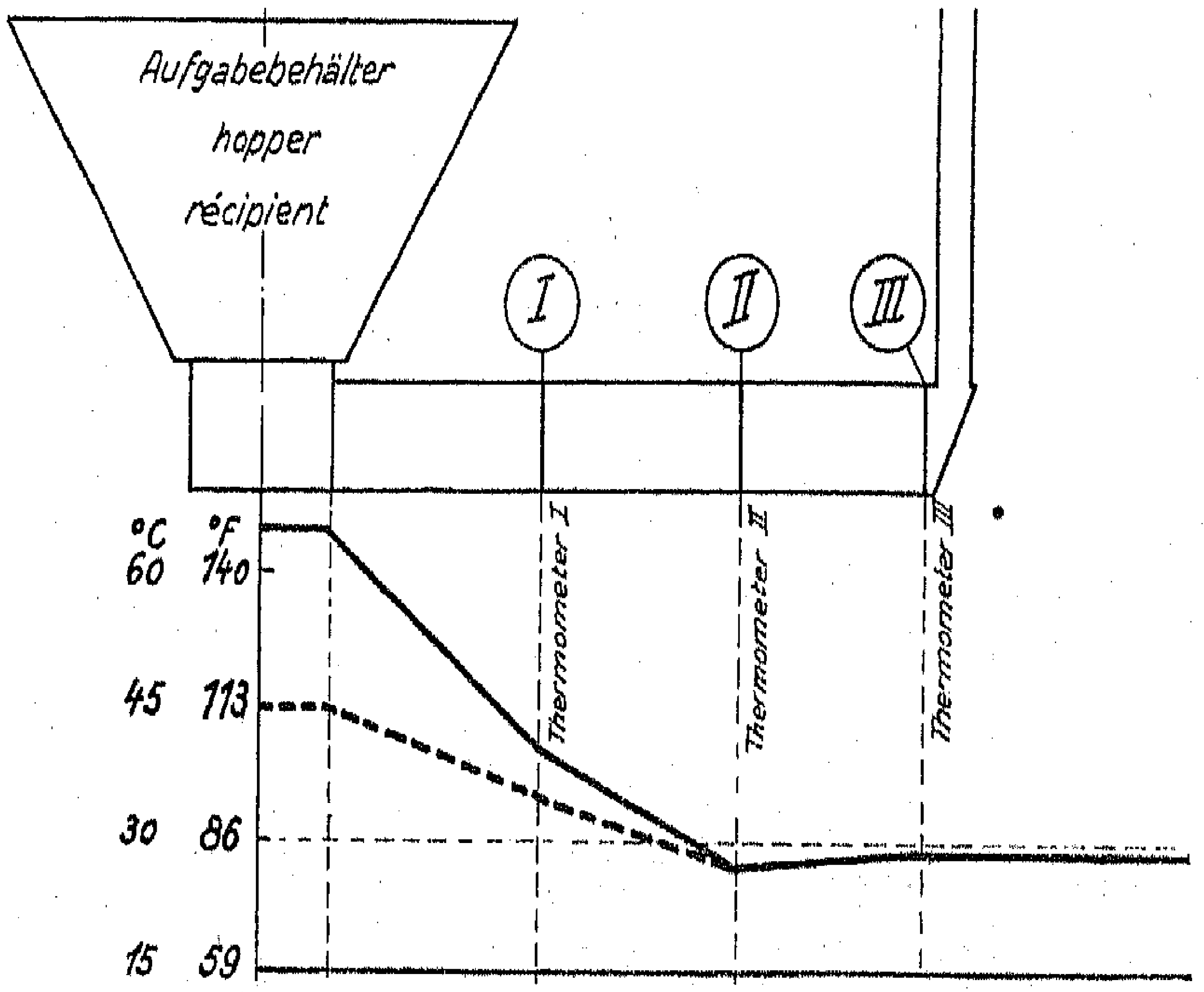


FIG. 35.—A CURVE ILLUSTRATING TEMPERATURE CONTROL.

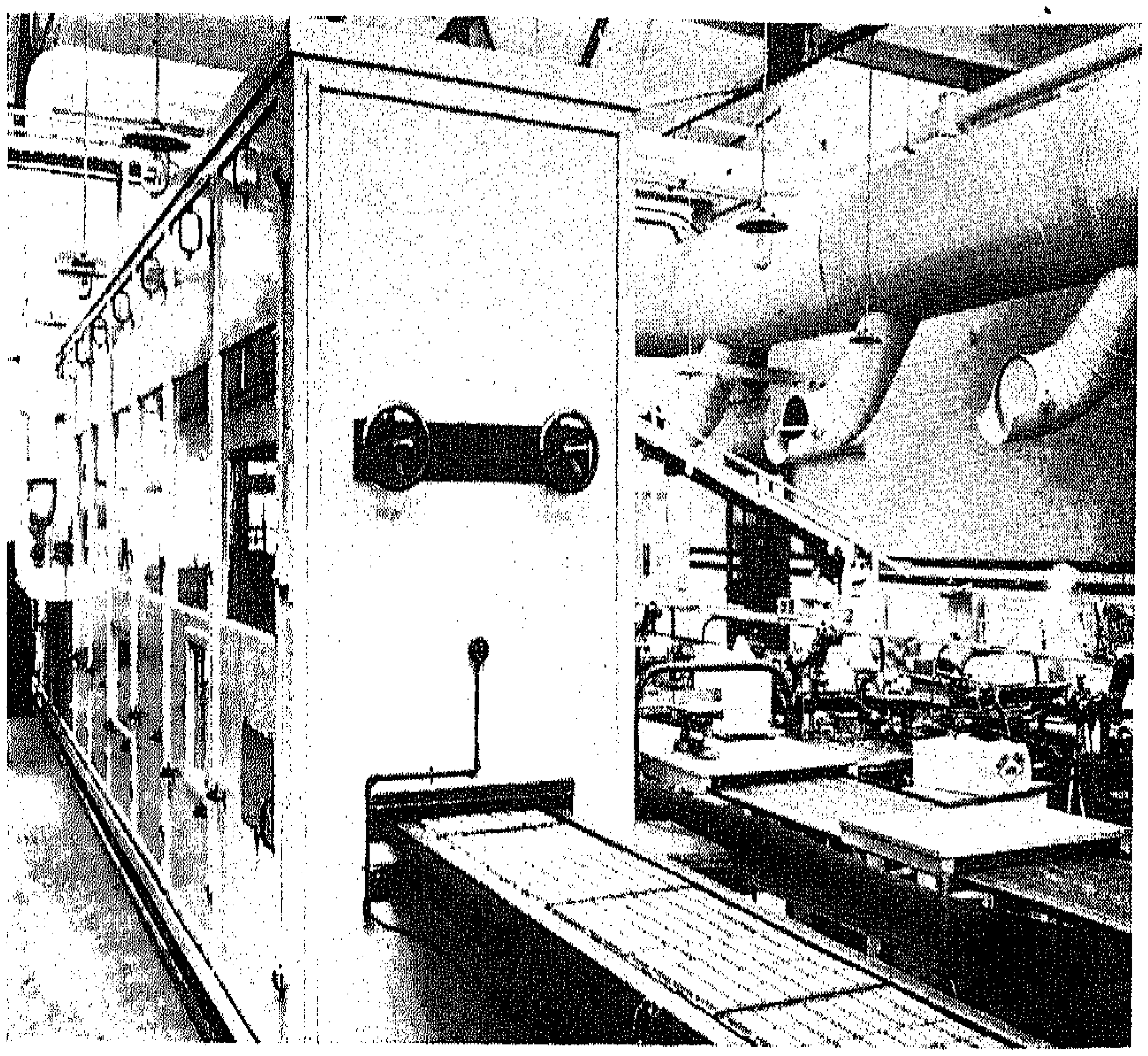


FIG. 36.—JENSEN MOULDING PLANT SHOWING MULTI-COOLER AND ADJACENT WRAPPING MACHINES.

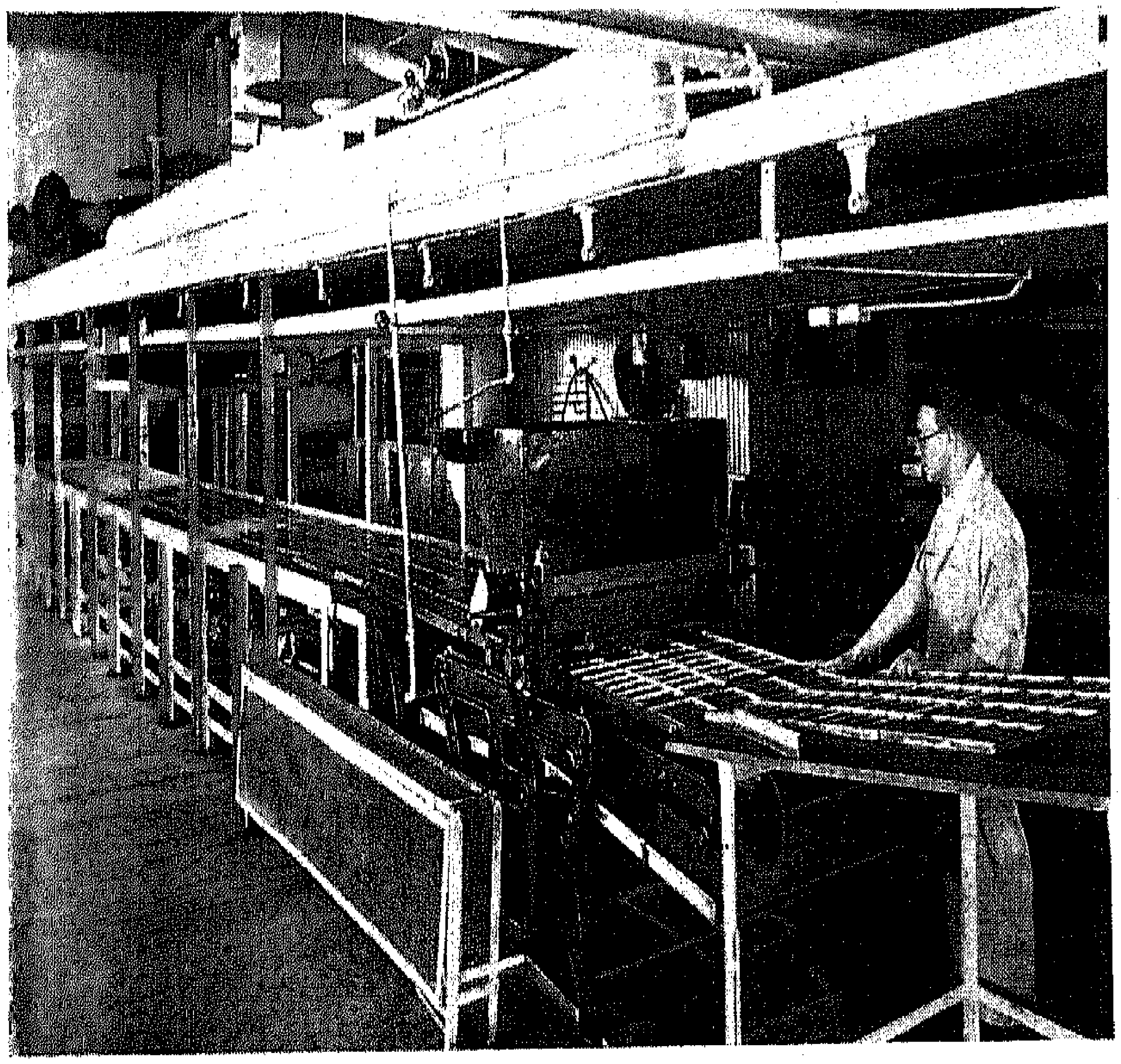


FIG. 37.—BAR MOULDING PLANT.

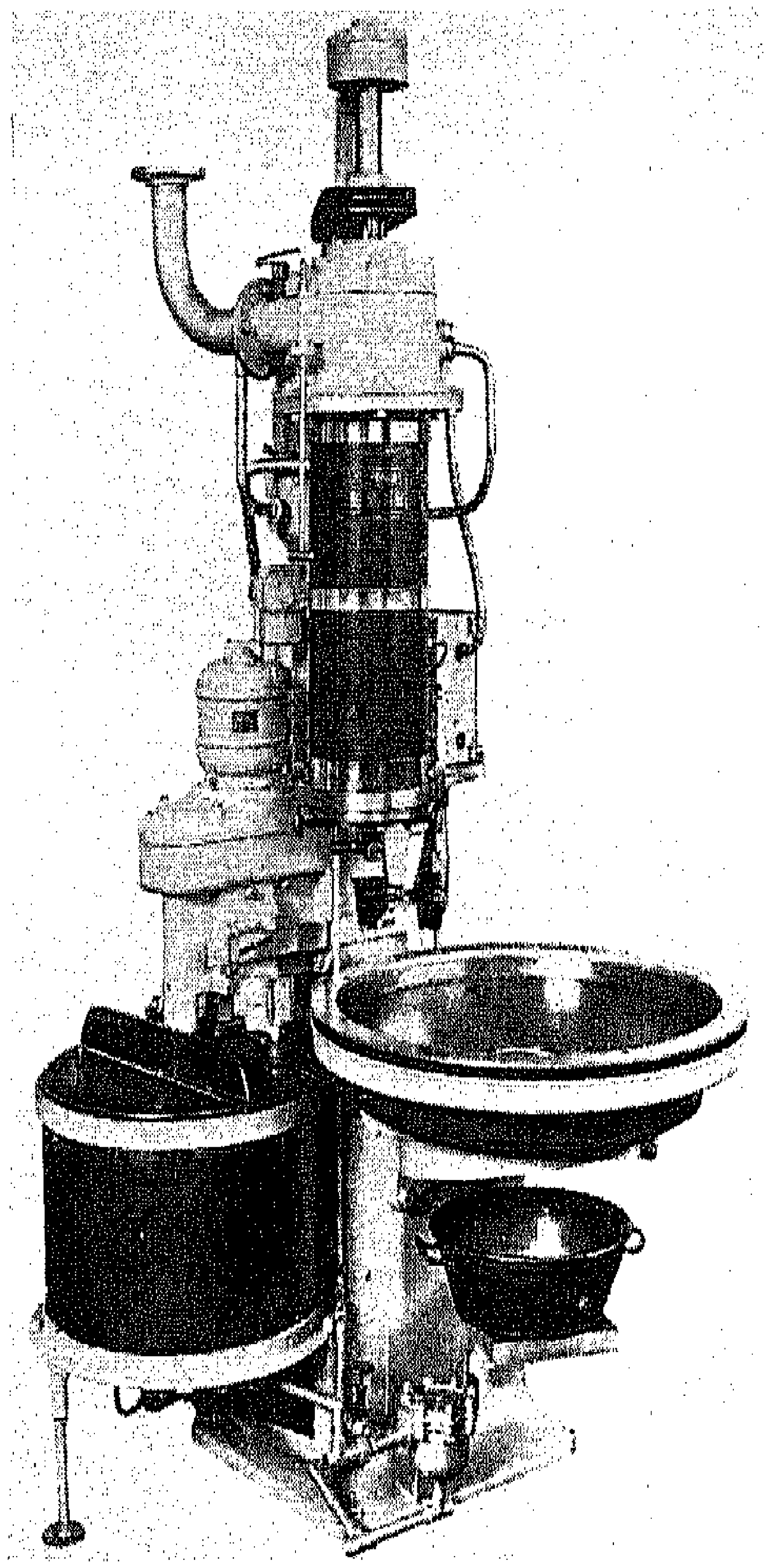


FIG. 38.—MICROFILM COOKER.

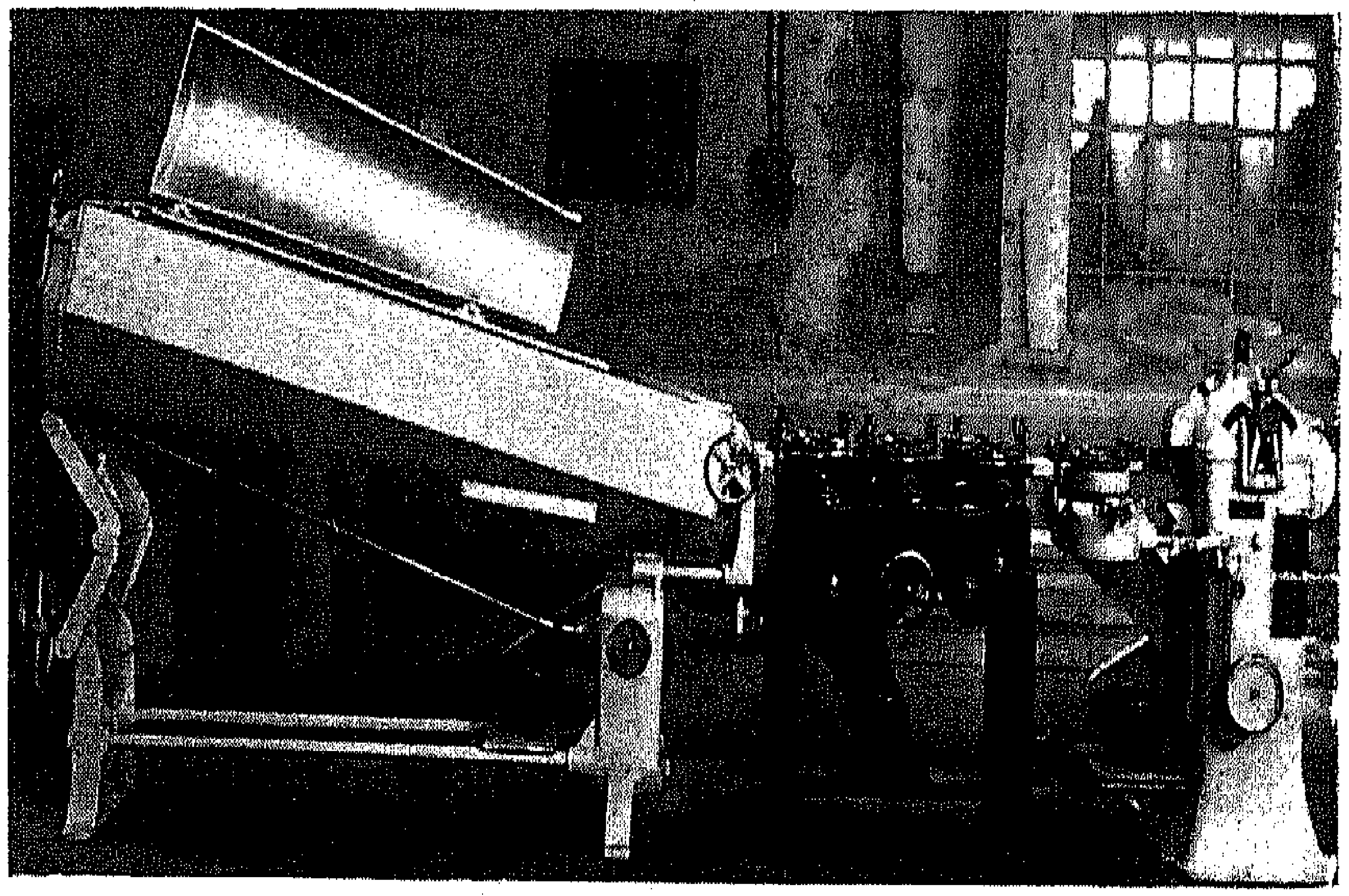


FIG. 39.—BATCH ROLLER, ROPE FORMER AND SIZER CONNECTED TO A ROSTOPLAST MOULDER.

temperature of the chocolate is directly proportional to the rate of tempering.

The lower minimum temperature of the mass ensures a more complete crystallisation of the various fat fractions, whilst an increased water-jacket temperature in the third phase ensures that the final crystalline structure in the chocolate will give a balanced and perfectly tempered mass.

Enrobing.—The chocolate is pumped through jacketed pipes to the enrobing machine (Fig. 59), in the well of which it is again agitated gently and maintained at a temperature of 88°-90°F., which is a maximum. All centres to be coated should themselves be 79°F. as they enter the coating chamber of the machine, so that no undue expansion will take place in the cold centre causing burst coatings, or retardation of cooling if the centre is too hot.

Cooling.—The cooling tunnel into which the coated centres pass from the enrober should be controlled at a temperature of 46°-47°F. This temperature, however, has to be considered in conjunction with the temperature and humidity of the air at the delivery end of the conveyor. The cooling tunnel temperature must be raised slightly as the humidity of the atmosphere increases, to prevent the moisture in the air condensing on the emerging cold chocolates. Room temperature should never exceed 72°F.; this can be effectively accomplished only by air-conditioning. The installation of air-conditioning plant in the chocolate factory assists the standardisation of temperatures used during manufacture. Even so, hygrometric and thermometric control is absolutely essential under all conditions. Fairly rapid cooling gives the best finish owing to the small size of fat crystals formed in the chocolate.

Handling.—The hands of the operators handling the chocolate-coated centres should be subjected to daily inspection for cleanliness, and any operator whose hands show any inclination to perspire must not be allowed to handle the chocolates, otherwise unsightly impressions on the goods and bloom are caused (Fig. 62).

Where the chocolates containing assorted centres are packed directly from the moving band into boxes, the centres should be fed into the enrober in predetermined proportions and positions on the band. This will reduce the surplus types reaching the end of the conveyor. Decorating of the chocolate is, of course, executed immediately after the goods leave the enrobing chamber either by hand or by an automatic decorating attachment. Decoration other than simple marking is essentially a manual operation. All centres passing through the chocolate enrober should be fairly free of dusting powder, which gives rise to imperfect coating, a very common occurrence in cheap chocolate goods. In the case of nut centres containing a fairly high percentage of easily extracted oil, a previous light panning with sugar syrup is a sound precaution. This light coating will prevent the heat of the chocolate causing the oil from the nut to mix with the couverture and give rise to bloom.

Blockmilk.—A progressive method of manufacturing milk chocolate of first-class quality involves the replacement of evaporated sweetened milk or milk-powder by Blockmilk, of Dutch manufacture, which is a form of evaporated sweetened milk, protected by a thin coating of cacao butter. The blocks of milk are specially prepared by condensation of sugar and fresh milk *in vacuo* at a low optimum temperature of 131°F. By this means the flavour and physical nutritive values of the fresh milk are retained. Provided dry, cool conditions prevail, Blockmilk may be stored in a state of perfect preservation for almost indefinite periods. Further protection to the actual milk is afforded by the thin coating of cacao butter, which isolates the milk substance from the atmosphere.

Analysis of Blockmilk A.S. shows the following approximate values:

Milk fat	13 per cent.
Sugar	40-42 per cent.
Milk solids	36-38 „ „
Moisture	9-10 „ „

Blockmilk is readily incorporated in chocolate mass, and reduces the time of refining and conching comparative with milk powder, and with it, somewhat higher temperatures may be employed in the conching process without detriment. It can be adapted to any formula on the basis of full-cream milk

powder in the proportion of 1·7 parts Blockmilk against 1 part of milk powder, allowance being made for the sugar-content of approximately 41 per cent. in the Blockmilk.

Technique of Cooling

Latent Heat.—As the cacao butter in chocolate is a combination of fats, each with its own melting or crystallisation point, the latent heat in cacao butter is generated progressively as the crystallisation point of each component is reached, and not at one specific temperature. The quality, appearance and shelf life of the chocolate are best when the greater percentage of this latent heat is extracted during the cooling process. This means that the maximum time must be allowed in the cooling tunnel in order to remove this latent heat. In actual practice, practically the whole of the latent heat in freshly coated chocolates is removed in the first 20 minutes of cooling. Therefore, 20 minutes is the absolute minimum cooling time to produce a stable product. Obviously a longer cooling period is necessary to provide a margin of safety and to allow for variations in couvertures. If chocolates are cooled too quickly, the latent heat cannot escape during the cooling process, owing to the outer surface case-hardening. It comes out later in the form of bloom when the chocolates are exposed to unfavourable conditions.

Chocolate Moulding

The moulding of chocolate lends itself more readily to mass production than enrober coating, since the procedure from liquid chocolate to wrapped block is almost entirely automatic. The surface finish of moulded goods is very much better than that of enrober coated or hand-dipped goods, owing to the contact of the chocolate with the smooth tinned surfaces of the metal moulds. In spite of the expensive initial outlay in moulding plant and equipment, there is a definite trend toward moulded centre work (Fig. 60).

The particular atmospheric conditions governing chocolate coating applies equally to the process of moulding (Fig. 61). Sugar bloom due to condensation of moisture on the cold surfaces, and fat bloom due to imperfect cooling or tempering will occur in moulded goods just as readily, if proper control is not exercised.

For the moulding process the tempered chocolate is pumped from the tempering kettles to the jacketed depositor, which fills spotlessly clean moulds set out on a synchronised conveyor with a predetermined quantity of chocolate. The moulds pass over a tapping section which expels air bubbles from the chocolate before the moulds enter the cooling tunnel. At the delivery end the blocks are de-moulded automatically, and the chocolate blocks pass directly to automatic wrapping machines.

A suitable temperature for moulding is 89°F.; larger blocks require a temperature of 86°-87°F., owing to the greater mass to be cooled.

Formulæ

Milk Chocolate (Blockmilk)

Bahia cacao nibs	4 lb.
Trinidad cacao nibs	3 ,,
Ceylon cacao nibs	5 ,,
Grenada cacao nibs	2 ,,
Lecithin	0·3 per cent. of mass
Blockmilk	41 lb.
Finely ground sugar	30 ,,
Cacao butter	13 ,,
Cacao butter to be added at conching stage	6 ,,

The Bahia, Trinidad and Grenada beans are roasted at 280°-290°F., and the Ceylon beans at 270°-275°F.

The Blockmilk is passed through the breaking or shaving machine. Under no circumstances pre-melt it, otherwise its preservation property is destroyed. It must be used from the solid blocks as required.

The cacao liquor is placed in the melangeur or vacuum kneading machine, heated to 90°F., then the ground sugar, Blockmilk and 6 lb. of melted cacao butter are added. The mass is mixed for 40 minutes and transferred to the vacuum dryer to expel moisture, then passed through the refiner with the steel rolls slightly eased. The mass is replaced in a melangeur or mixer with 7 lb. added cacao butter, mixed thoroughly, and

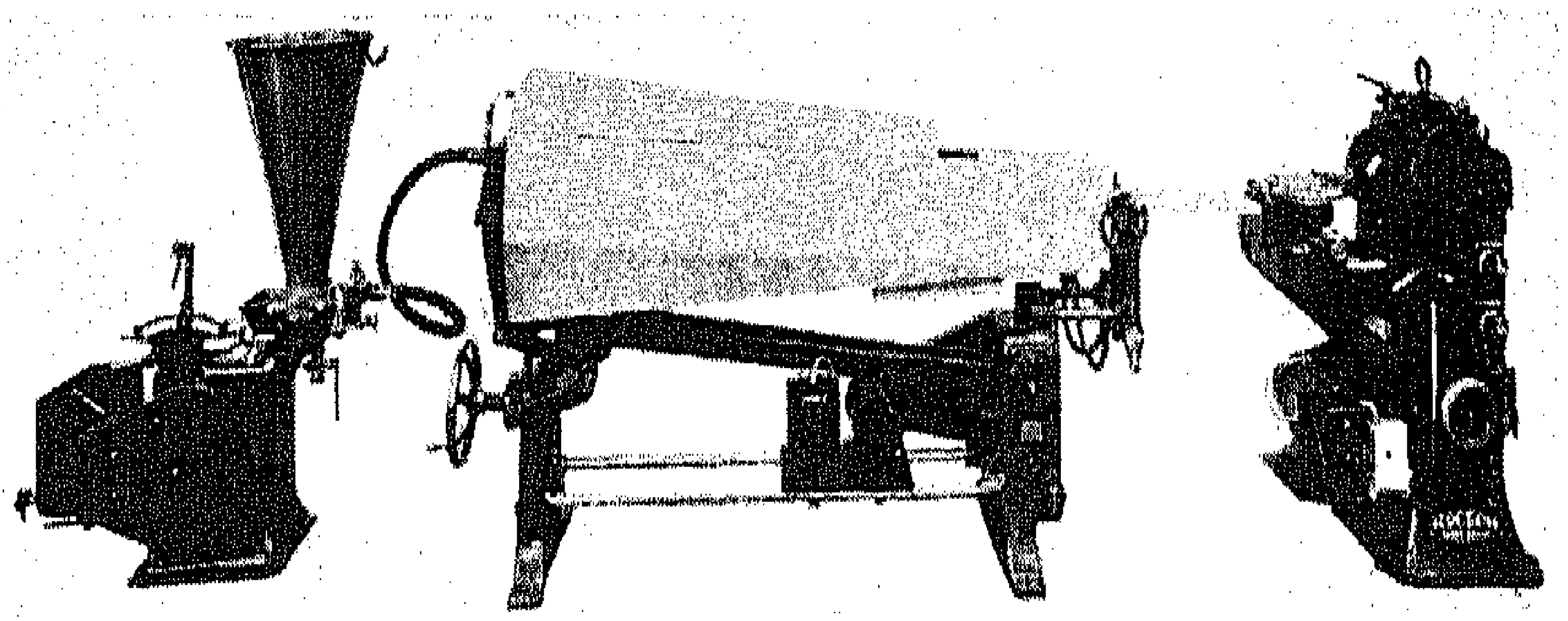


Fig. 40.—Soft Centre Filler, Batch Roller and Rostoplast in Series.

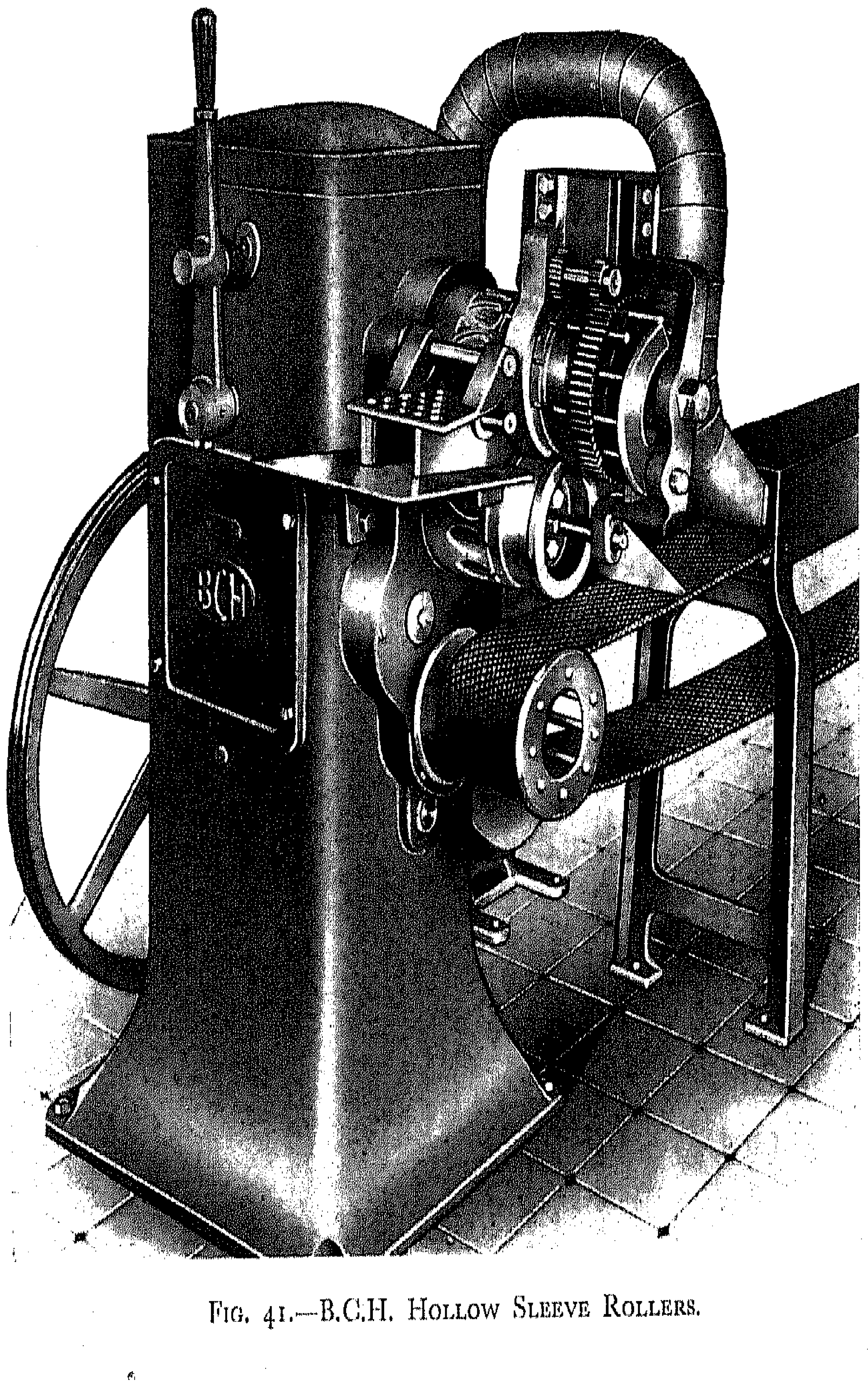


Fig. 41.—B.C.H. Hollow Sleeve Rollers.

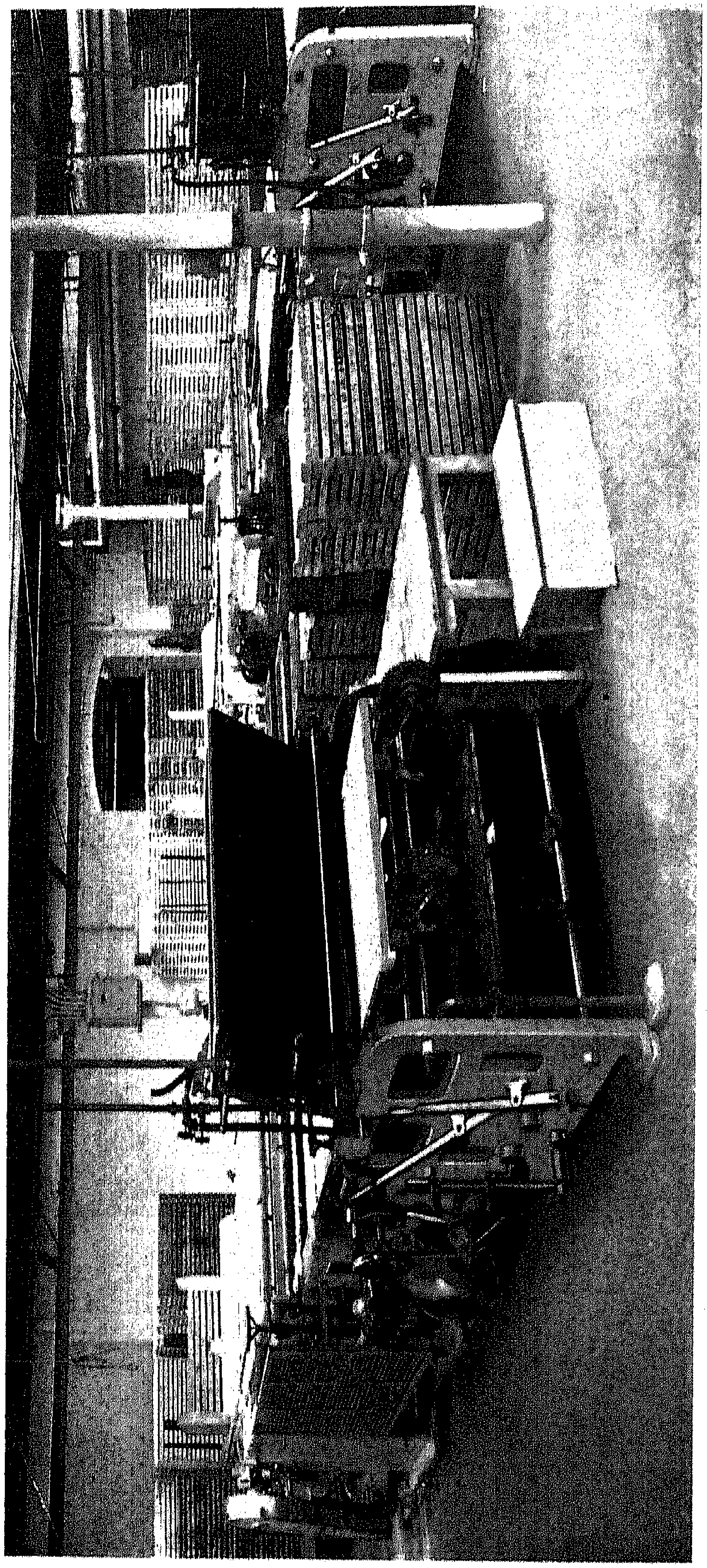


Fig. 42.—Master Starch Machine.

again refined with close rolls. The refined chocolate flake is placed in a melting kettle with the balance of cacao butter, and when mixed, transferred to a longitudinal conche. It is conched for 24 hours at 100°F., then for a further 24 hours at 140°F. The milk chocolate is then ready for tempering, preparatory to moulding or coating. An excellent snap is obtained if the correct tempering and operating conditions are observed throughout.

Strong-flavoured Plain Chocolate

Trinidad cacao nibs	30 lb.
Accra cacao nibs	20 ,,
Cacao butter to be added at conching stage	8 ,,
Finely ground sugar	50 ,,
Cacao butter	7 ,,
Lecithin	0·3 per cent. of mass

The beans are roasted at 290°F. The resultant nibs will possess a rich full flavour. The nibs are blended, ground and placed in the melangeur with the sugar and 7 lb. cacao butter, being thoroughly mixed to a homogeneous paste and passed through the refiner. The mass is refined twice, first through freely adjusted rolls, then again through closely adjusted rolls, and transferred to the conche with 8 lb. cacao butter and lecithin. It is conched for 72 hours at 160°F., or until a test sample shows a fineness of 35 microns or less on the micro-projector. 1-2 drams of vanillin or cinnamon may be added to the batch in the conche, if such flavours are required.

Plain Chocolate (of Excellent Flavour)

Caracas cacao nibs	20 lb.
Accra cacao nibs	30 ,,
Cacao butter to be added at conching stage	8 ,,
Finely ground sugar	50 ,,
Cacao butter	7 ,,
Lecithin	0·3 per cent. of mass

The Accra beans are roasted at 290°F., and the Caracas at 275°F.

The blended nibs are ground on the liquor mill, and placed in the melangeur or vacuum kneader with the sugar and 7 lb.

cacao butter, mixed to a paste and refined. It should be borne in mind that the fineness of the sugar and the efficiency of the liquor mill have a direct bearing on the time of refining. The refined mass is placed in a longitudinal conche or circular conche, and processed at 160°F. until a 35-micron fineness is shown on a micro-projector. The chocolate is then ready for tempering prior to moulding or coating.

Plain Couverture

Arriba cacao nibs	25 lb.
Caracas cacao nibs	25 „
Trinidad cacao nibs	22 „
Cacao butter to be added at conching stage	30 „
Finely ground sugar	100 „
Cacao butter	14 „
Lecithin	0·3 per cent. of mass
Vanillin	½ oz.

The Arriba and Caracas beans are roasted at 275°F.; the Trinidad at 290°F. The nibs are blended and ground in the liquor mill, then mixed thoroughly with the sugar and 14 lb. cacao butter in the mixer. The mass is refined and transferred to a mixing kettle, the balance of cacao butter and lecithin added, mixed and placed in pots of the conche, processing for 72 hours at 160°F. The vanillin is added near the end of the process. The chocolate is tested for fineness on micro-projector before discharging.

Plain Chocolate (Moulding)

Ceylon cacao nibs	4 lb.
Trinidad cacao nibs	9 „
Grenada cacao nibs	20 „
Accra cacao nibs	11 „
Cacao butter to be added at conching stage	9 „
Finely ground sugar	60 „
Ground roasted almonds ..	4 „
Cacao butter	7 „
Lecithin	0·3 per cent. of mass
Vanillin	1 oz.

The Trinidad, Grenada and Accra beans are roasted at 290°F.; Ceylon beans at 275°F. The blended nibs are passed through the liquor mill and mixed thoroughly with sugar, ground almonds and 7 lb. cacao butter in the melangeur. The mass is refined twice, and transferred to the conche with 9 lb. added cacao butter and lecithin and processed for 72 hours at 160°F. The vanillin is added near to the end of the process. The mass is tested for fineness on micro-projector and transferred to the tempering kettles, and finally pumped to the depositor.

Cocoa Powder Production

Correlative to the manufacture of chocolate is the production of cocoa powder. The process provides a source of cacao butter and a food product of high dietary value. Although there are several variations in the methods employed to produce cocoa powder, the fundamental principles are the same.

Alkalisation

The cacao nibs or liquor are first alkalised with potassium carbonate to render the resultant cocoa powder so-called "soluble," which is a misnomer as cocoa powder is totally insoluble in water. Alkalisation has the effect of breaking down the cell walls of the cacao nib, and releasing starches and colloids, which improve the suspension of solid particles in water. The alkalised mass is dried, milled and subjected to hydraulic pressure to express the cacao butter, the residual cake being crushed and powdered.

The process of alkalisation is broadly as follows: A quantity of roasted nibs, the amount being determined by plant capacity, is reduced to liquor in the mills. This mass is pumped into steam-jacketed mixers, and between 1 and 2 per cent. of potassium carbonate in 10 per cent. solution with distilled water added. The whole is thoroughly mixed and heated to 112°F. for approximately 5 hours to expel moisture. Some processes proceed from this point with neutralisation of the alkali by the addition of a calculated amount of glacial acetic acid or tartaric acid.

Pressing.—From the mixers, the alkalised liquor is pumped into the pots of a hydraulic cocoa press fitted with automatic filters (Fig. 19), and the mass pressed until the desired fat content remains in the cocoa cakes. The press cakes are extracted from the pots, cooled rapidly and passed into a "Rema" fully automatic cocoa-producing plant, in which it is pulverised at a low temperature to a fine powder. Thence it is bagged ready for automatic packaging (Fig. 63).

Precautions.—If the broken press cake is to be stored before it reaches the pulverising stage, it should be laid out thinly to allow maximum evaporation of contained moisture. The cake is ground at 77°-86°F. in the mill, which heat is usually generated by the friction set up in the mill. At this temperature, the reddish-brown colour of the powder is best developed. The temperature of the cooling air in the powder-producing plant should be 41°-46°F., and, naturally, it should be dehumidified. If the air passing below the pulveriser is 46°F., the resultant temperature in the tempering chamber will be 59°-66°F., the temperature at which the cocoa powder should leave the chamber.

It is essential to remove the contained heat from the pressed cakes on extraction from the presses as quickly as possible, as this heat and the alkali under influence of heat will tend to darken the colour of the cocoa (Fig. 64).

Control of Flavour.—As in the case of bean blending for chocolate manufacture, so are certain combinations of beans used to give distinctive flavours to cocoa powders. In some instances, chocolate or sweetened cocoa powders are required, in which the alkalisation process has, for specific reasons, been omitted. Chocolate powders are simply cocoa powder mixed with finely powdered sugar in varying proportions, according to requirements; 10 per cent. Farina (potato starch) is sometimes added as a thickener.

To determine Percentage of Fat in Cocoa Powder

The calculation is based on the following equation:

$$f = 100 - \frac{m\,(100 - b)}{k}$$

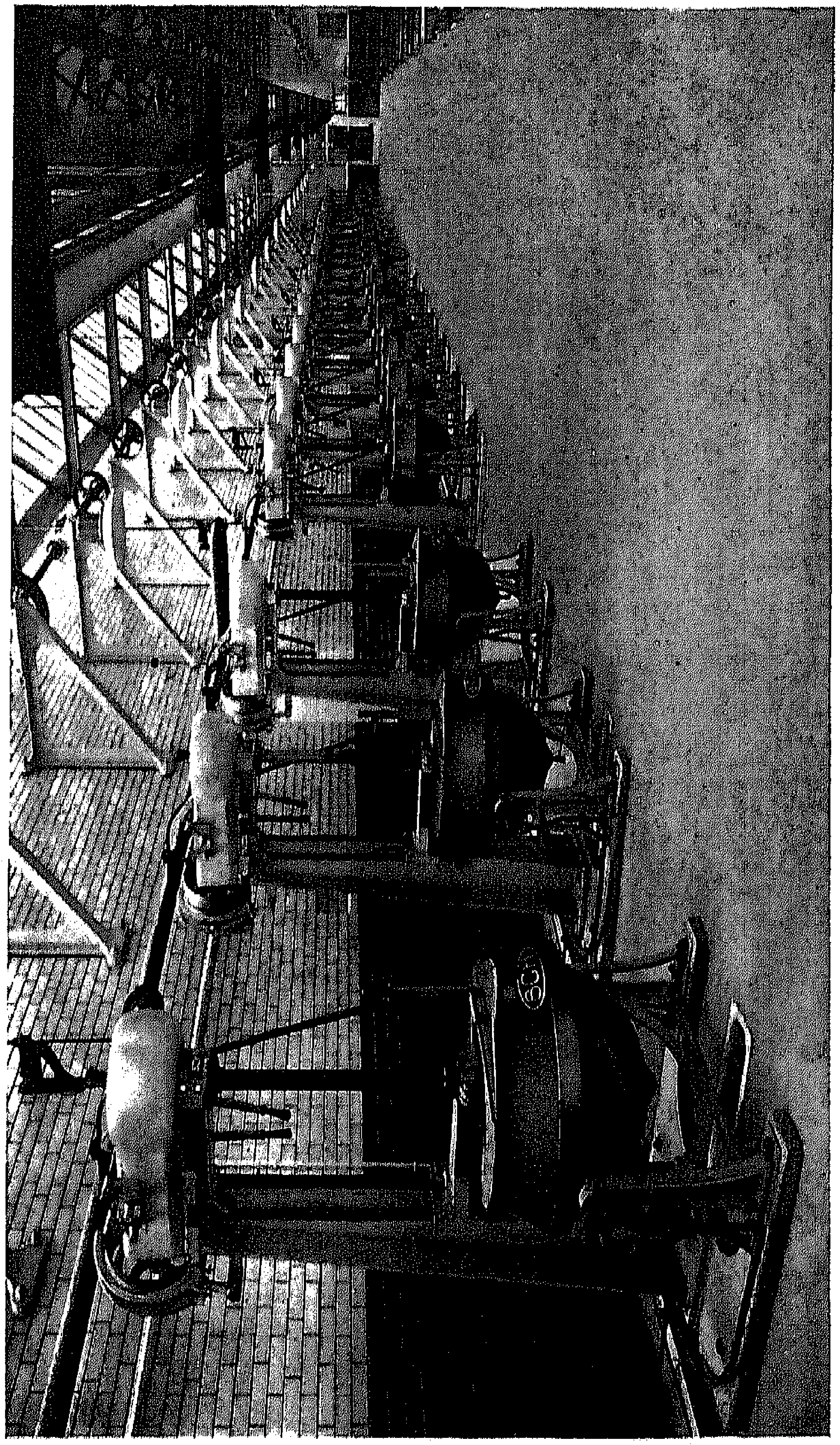


FIG. 43.—BATTERY OF B.C.H. STEAM STIRRING PANS.

Fig. 44.—B.C.H. Toffee Cooling Plates.

where m = weight of mass to be expressed.
b = percentage cacao butter in mass.
f = percentage cacao butter remaining in press cake.
k = weight of press cake.

Thus, if the percentage of cacao butter in the cacao liquor is 50, the mass to be expressed 130 lb., and the weight of the resultant press cake is 86 lb., the percentage of fat in the final powder will be:

$$f = 100 - \frac{130\ (100 - 50)}{86} = 24{\cdot}4$$

To determine the Weight of Cacao Butter to be expressed to obtain a given Percentage of Fat in Cocoa Powder

This calculation is based on the following equation:

$$a = m \times \frac{b - f}{100 - f}$$

where a = weight of cacao butter to be expressed.
m = weight of mass to be expressed.
b = percentage cacao butter in mass.
f = percentage cacao butter remaining in press cake.

Thus, if 23 per cent. fat content is required in the powder obtained from 130 lb. of original liquor containing 52 per cent. cacao butter, the weight of cacao butter to be expressed is:

$$a = 130 \times \frac{52 - 23}{100 - 23} = 48{\cdot}9 \text{ lb.}$$

For greater accuracy, allowance should be made for the moisture content of the cake at the time of pressing, otherwise the percentage of fat in the final dry powder will be higher than that calculated.

Formulæ

Cocoa Powder

Accra cacao nibs	75 per cent.
St. Lucia cacao nibs	25 „ „

The beans are roasted at 290°F. The blended nibs are ground and alkalised as described above. The mass is placed in a hydraulic press and the calculated weight of cacao butter expressed to give the required percentage of fat in the final powder. The cakes are transferred to a cake breaker immediately, and the pieces passed under a cold air current, thence to the cocoa powder plant.

Chocolate Powder

Ceylon cacao nibs	60 lb.
Arriba cacao nibs	60 „
Trinidad cacao nibs	30 „
Grenada cacao nibs	30 „
Powdered cocoa	30 „
Finely ground sugar	26 „
Coumarin	¼ oz.

The Arriba, Trinidad and Grenada beans are roasted at 290°F., and the Ceylon at 275°F. The nibs are blended and passed through the liquor mill, alkalised and placed in the pots of the hydraulic press. Sufficient cacao butter is expressed to obtain a cake containing approximately 23 per cent. cacao butter. The cakes are passed through the breaker, cooled and conveyed to the powder plant. Finally, the dressed cocoa powder, sugar and coumarin are mixed in a Gardner mixing machine and packed into cans by automatic weighing and filling machines immediately to prevent absorption of moisture from the atmosphere (Fig. 65).

CHAPTER IX

TOFFEES, CARAMELS AND FUDGE

Creamy Toffee

ONE of the most important factors in the process of manufacturing "Creamy" Toffees is the subjection of the main raw materials to a prolonged mixing in the uncooked state before actual boiling. This process ensures a high degree of homogeneity, or emulsification, and thorough distribution of each ingredient throughout the mass, so that no separation of fats occurs during boiling. As the solids content decreases in a toffee, a colloid must be added to maintain a state of suspension of the fat content, otherwise this ingredient will separate out. Gelatin is an efficient emulsifying agent, which, used in the proportion of 1 per cent. of the total batch, will maintain a state of equilibrium in the toffee. Lecithin possesses amongst several other characteristics the property of emulsification and, when obtainable, a 0·5 per cent. addition may be used in toffees to produce results coincident with gelatin. The use of a colloid is an expedient resorted to only in times of shortage of condensed milk, which is a natural emulsifier.

Balance of Composition.—In view of the considerable amount of agitation a toffee receives in process and during the plastic wrapping stage, it is important to ensure that granulation does not occur. Likewise, a sticky product must be avoided. Both states have been quite common in toffees offered for sale, to the annoyance of the consumer. To prevent either granulation or hydrotropic collapse of the toffee, the sugar content must be fully dissolved in boiling, and the corn syrup content should not vary from 28 to 32 per cent. of the total raw materials used, and the fat well distributed, atmospheric working conditions being assumed satisfactory.

In practice, the ingredients of a toffee or caramel are pre-mixed in large quantities, several tons at a time, and

Proceed as for unwrapped caramels.

In the case of nut-filled toffees and caramels, the nuts are added at the end of the boiling process and allowed to mix through the batch.

Clear Fruit Caramels

Granulated sugar	30 lb.
Corn syrup	20 ,,
Gelatin	4 oz.
Hard fat	15 lb.
Citric acid	6 oz.
Fruit essence	1 fl. oz.

The gelatin is pre-soaked in cold water until just pliable. The sugar and corn syrup are boiled to 268°F. The soaked gelatin and hard fat are added, stirred well; finally flavour and citric acid are added. The batch is poured on a cooling slab and, when plastic, cut on a caramel cutting machine.

Creamy Toffee (Using Blockmilk)

Tate's Grade 30 pieces	60 lb.
Blockmilk C.S.	39 ,,
Corn syrup	60 ,,
Hard fat	25 ,,
Butter	6 ,,
Vanillin	1 oz.
Salt	½ lb.

The Blockmilk is broken into small pieces. The melted hard fat is placed in the pre-mixing machine and the Blockmilk added. The machine is set in motion, and the corn syrup, butter, sugar and salt added. The batch is allowed to mix until the mass is a uniform cream. It is then placed in a steam stirring kettle and cooked to 265°F. The steam is turned off and vanillin added, the latter being allowed to mix through the batch, which is poured on water-cooled slabs and processed as described for the previous formula.

Blockmilk has a big storage advantage as it is less bulky and more easily handled than condensed milk.

An approximate analysis of Blockmilk C.S. is: Milk fat, 11-12 per cent. Sucrose, 40-42 per cent. Moisture, 17 per cent.

Toffee Mints

Corn syrup	60 lb.
Skimmed condensed milk	10 ,,
Tate's Grade 20 pieces	35 ,,
Hard fat	2½ ,,
Peppermint oil	1½ fl. oz.

The ingredients are thoroughly mixed, with the exception of the peppermint oil, prior to cooking, placed in a steam stirring pan, and cooked to 263°F. The batch is poured on a water-cooled oiled slab and transferred to a pulling machine in motion, peppermint is added gradually, pouring on the batch carefully. The mass is allowed to aerate until light, passed through a kiss cutting machine and wrapped, when cool, in waxed paper on a twist wrapping machine. Alternatively, the batch may be placed in a vertical batch feeder and passed through a plastic wrapping machine. The former method produces the more attractive finish.

Fudge Formulæ

Vanilla Fudge

Tate's Grade 30 pieces	35 lb.
Corn syrup	18 ,,
Fondant base	25 ,,
Condensed milk	25 ,,
Hard fat	10 ,,
Vanillin	1 oz.

The melted fat, sugar, corn syrup and condensed milk are pre-mixed thoroughly, placed in a steam stirring pan, and cooked at 100 lb. steam pressure to 240°F. The steam is turned off and the batch cooled to 200°F., and the fondant and vanillin are added. The latter ingredients are allowed to beat well through the batch, which is poured on to oiled cooling slabs or in oiled tin trays. The mass quickly grains. It is then cut into pieces of required size. Fudge may be scored whilst still firmly plastic, and finally broken when set. A wide range of flavours may be substituted for vanillin.

Fruit Fudge

Tate's Grade 10 pieces	26 lb.
Corn syrup	15 ,,
Condensed milk	20 ,,
Drained cherry pieces	2 ,,
Hard fat	8 ,,
Fondant base	24 ,,
Oil of almonds	$\frac{1}{8}$ fl. oz.

The sugar, corn syrup, condensed milk and melted fat are premixed and cooked to 244°F. The steam is turned off and the batch cooled to 200°F., the fondant, cherry pieces and oil of almonds are then added and stirred well through the batch, which is poured on an oiled cooling slab. The mass should be scored whilst plastic, and divided into pieces when cold.

Any well-drained preserved fruit may be used in place of cherries with the addition of the appropriate essence to enhance the flavour.

Chocolate Fudge

Tate's Grade 40 pieces	35 lb.
Corn syrup	20 ,,
Fondant base	25 ,,
Skimmed condensed milk	25 ,,
Hard fat	5 ,,
Cacao liquor	7 ,,
Vanillin	1 oz.

The ingredients are pre-mixed, with the exception of the fondant and vanillin, cooked to 240°F., and manipulated as described in previous formula.

Caramel Fudge (Using Frappé)

Tate's Grade 30 pieces	35 lb.
Corn syrup	15 ,,
Fondant base	25 ,,
Frappé	20 ,,
Skimmed condensed milk	25 ,,
Hard fat	10 ,,
Vanillin	1 oz.
Salt	4 oz.

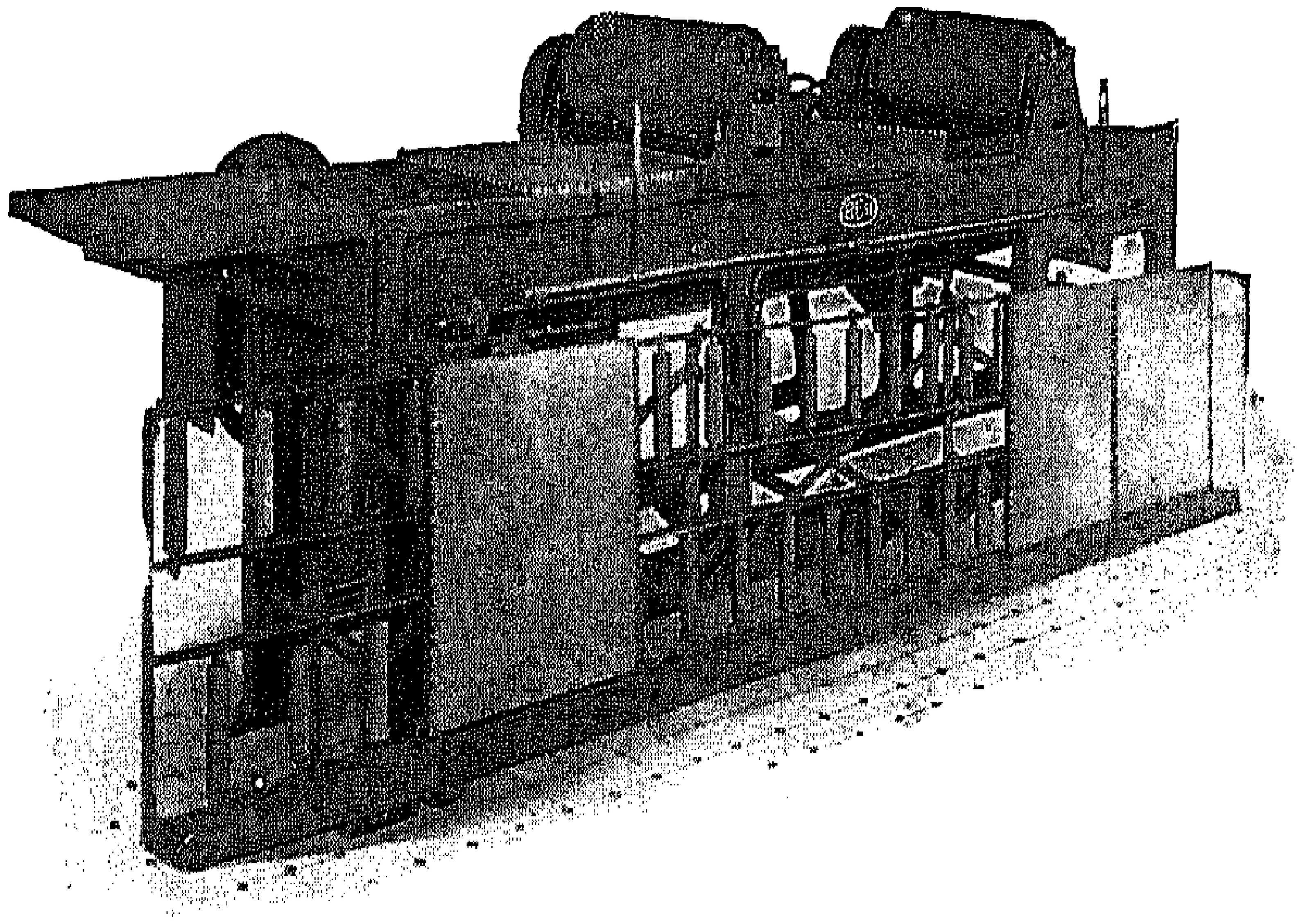


Fig. 45.—B.C.H. Toffee Cutting Machine.

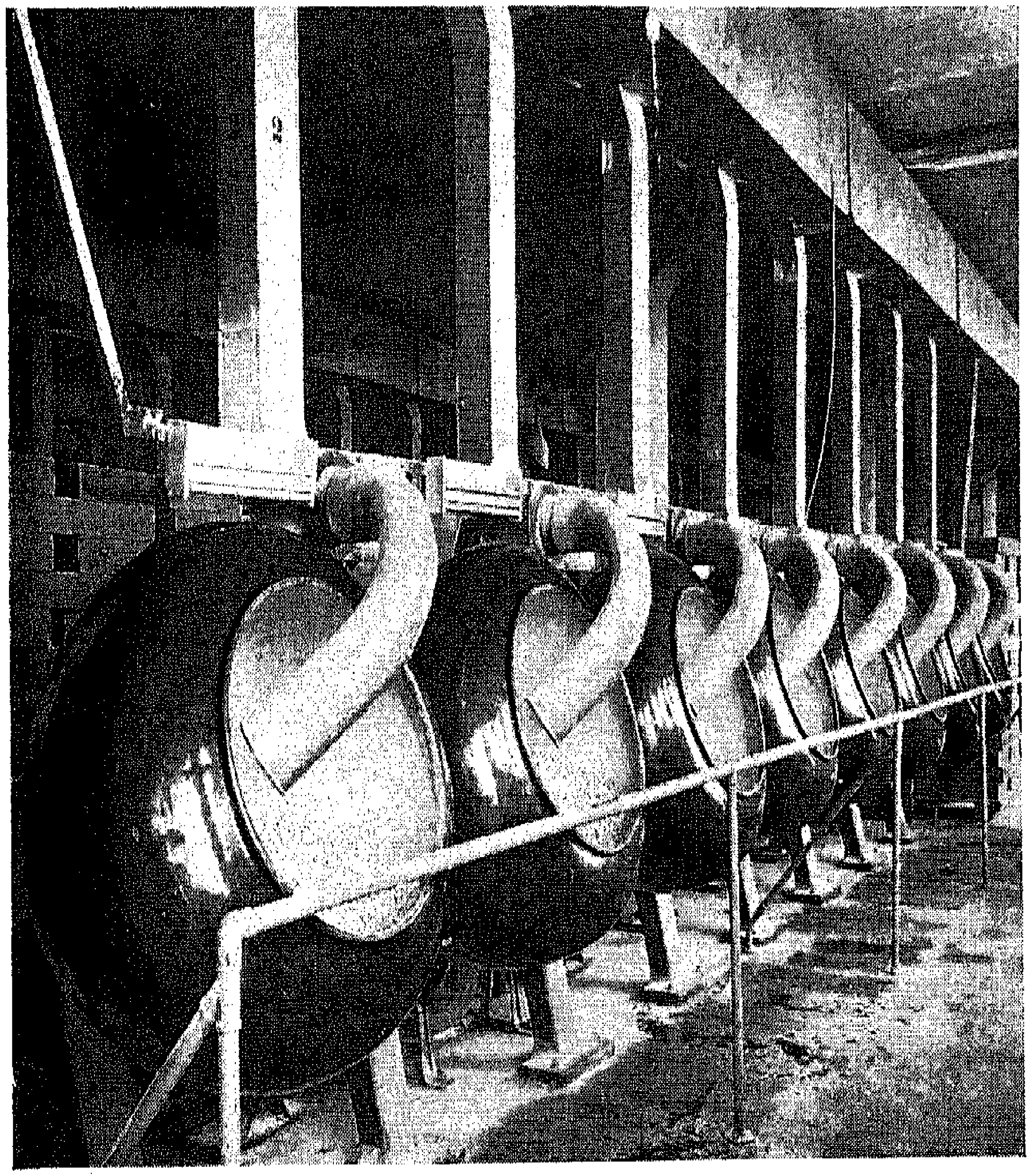


Fig. 46.—Battery of Dragée Pans.

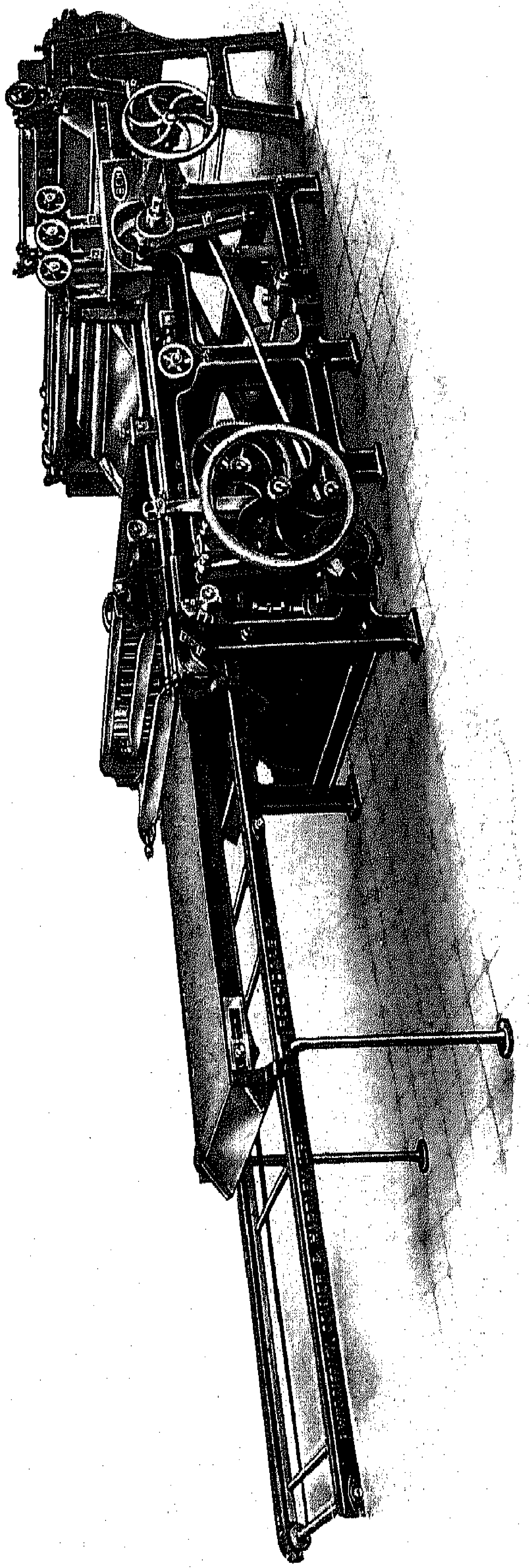


FIG. 47.—B.C.H. LOZENGE MACHINE.

The frappé should be made first. 1 lb. of egg or soya albumen is dissolved in 2 lb. of water. 8 lb. of white sugar, 8 lb. corn syrup in 2 lb. of water are cooked to 245°F., after having thoroughly dissolved the sugar. 8 lb. of corn syrup is placed in a whisking machine, the cooked batch added and beaten for 4 minutes. The albumen solution is poured in, and the batch beaten for 15 minutes.

The fudge batch is cooked to 245°F., cooled to 200°F., when the fondant and vanillin are added and allowed to mix well. Finally the frappé is added and mixed until well incorporated. The fudge is poured out on oiled slabs and cut when set.

The addition of frappé results in a lighter, more easily assimilable fudge due to aeration.

Garden Mint Kisses

Granulated sugar	56 lb.
Corn syrup	28 „
Garden mint essence, No. 1 (Dega Brand)	5 fl. oz.

The sugar and corn syrup are thoroughly dissolved in 1 gal. of water in a steam pan. The batch is cooked to 264°F., and transferred to an oiled cooling slab. A few ounces of corn starch are placed in the centre of the batch and the garden mint essence added. The batch is kneaded, and finally placed on the arms of a candy pulling machine. It is allowed to aerate thoroughly, transferred to a batch roller and passed through a kiss cutting machine. The pieces are immediately machine wrapped in waxed paper. These kisses possess a rather fascinating flavour and leave the palate refreshed.

A slight modification of the texture may be obtained by incorporating a ½ lb. of hard fat shavings into the batch whilst on the slab. This increases the masticity period.

This formula was evolved by the author and the kisses subjected to a consumer-reaction test with satisfactory results.

CHAPTER X

NOUGAT AND MARSHMALLOW

NOUGAT and marshmallow are closely related, insomuch as both products possess the same basic ingredients—sugar, corn syrup, gelatin or albumen. Both are subject to rapid beating to produce aeration and give them their characteristic white appearance. Nougat and marshmallow made with gelatin as the colloid possess a degree of elasticity, whereas those made with albumen are of short texture.

It might be mentioned that marshmallows made for casting in starch are not easy to produce so that they are consistently satisfactory. In the U.S.A., where marshmallows are a national favourite, lengthy research on the properties and production of marshmallows has been undertaken in order to determine the best methods and physical conditions for producing the perfect type. Isolated soya proteins are added to nougat to increase the total protein content, thereby increasing its dietary value, and are also the subject of extensive research. It is advisable to standardise beating periods in both nougat and marshmallow production.

Formulæ

A good formula for hard nougat of the chewing type, which is usually cut into bars or cakes and wrapped in waxed paper, is as follows:

1	Granulated sugar	60 lb.
	Corn syrup	70 ,,
3	Gelatin	3 ,,
	Fine coconut	20 ,,
	Vanillin	1 oz.

The gelatin is soaked in cold water until pliable. The sugar and corn syrup are placed in a steam pan with sufficient water to cover, and heated until sugar is dissolved completely, then

cooked to 268°F. The batch is poured into a slightly warm nougat beater, and the gelatin added and beaten briskly until quite light and stiff, the fine coconut and vanillin then being added and allowed to mix in thoroughly. The batch is poured either on to wafer paper or well-dusted and oiled cooling slabs to the thickness required, divided into conveniently sized slabs, and cut into bars on the nougat knife. If necessary, one half of the batch may be coloured pink in the beating machine and poured on the first layer on the slab to produce a two-coloured bar. If a soft nougat is required it should be cooked to 260°-265°F. If the batch is cooked *in vacuo*, Tate's Grade 30 sugar may be substituted for granulated in all nougat formulæ; the colour of the final nougat is not impaired.

Albumen Nougat

Granulated sugar	56 lb.
Corn syrup	56 ,,
Albumen	15 oz.
Fine coconut	10 lb.
Vanillin	1 oz.

The albumen is dissolved in 3 pints of water, whipped in a rapid whisking machine just before use, and placed into the nougat beater whilst in motion. The sugar and corn syrup are cooked to 265°F., and poured gradually into the beating machine. Beating is continued until light and firm, then the coconut and vanillin added. The ingredients are allowed to mix well, then discharged to oiled and well-dusted pans, and transferred to wafer-paper lined, or oiled and dusted cooling slabs. When sufficiently cool the batch is divided into cakes and cut on the nougat-cutting machine. Apart from the flavour angle, desiccated coconut assists cutting.

Nougat Montèlimar

This type of nougat, which originated in France, is distinguished by the variety of materials which may be added to enrich the nougat base; glacé fruits, almonds, pistachio nuts, cashew nuts, and prepared agar jellies are examples. An essential ingredient of Nougat Montèlimar is honey.

The following is a sound formula:

Granulated sugar	35 lb.
Corn syrup	30 „
Honey	10 „
Almonds	17 „
Glacé fruits	7 „
Pistachio nuts	4 „
Albumen	8 oz.
Vanillin	½ oz.

Before commencing manufacture, all fruits and nuts are dried in a warm stove to prevent weeping. The albumen is dissolved in 3 pints of water and whipped to a light froth in the whisking machine. The sugar and corn syrup are cooked to 266°F., the honey added and allowed to boil through the batch. The batch is poured into a nougat beater, set in motion, then the whipped albumen added, and beating continued until light and firm. Nuts, fruits and vanillin are weighed into the beater, mixed well and poured on wafer-lined cooling slabs. The mass is levelled to the desired thickness, and the surface of the still hot batch is covered with wafer paper. When the nougat is convenient to handle, it is divided into cakes and cut on nougat knives. The bars are wrapped in waxed paper.

Nougat Wafers

A batch of nougat is made as described for albumen nougat, and the coconut and vanillin, with 1-2 lb. broken wafer biscuits added, are allowed to mix through the batch, which is poured on dusted slabs and levelled to a fraction less than the width of a wafer biscuit. When ready for handling, the nougat is cut into pieces slightly smaller than a wafer biscuit and about 5 mm. thick. As each piece comes off the machine, it is sandwiched between two wafer biscuits and packed in tight lines in trays to assist adhesion. Finally, about a dozen nougat sandwiches at a time are taken up and each edge dipped in tempered chocolate. The chocolate-edged sandwiches are placed singly on glazed plaques, passed through a cooler quickly, then packed in cartons, with waxed paper divisions.

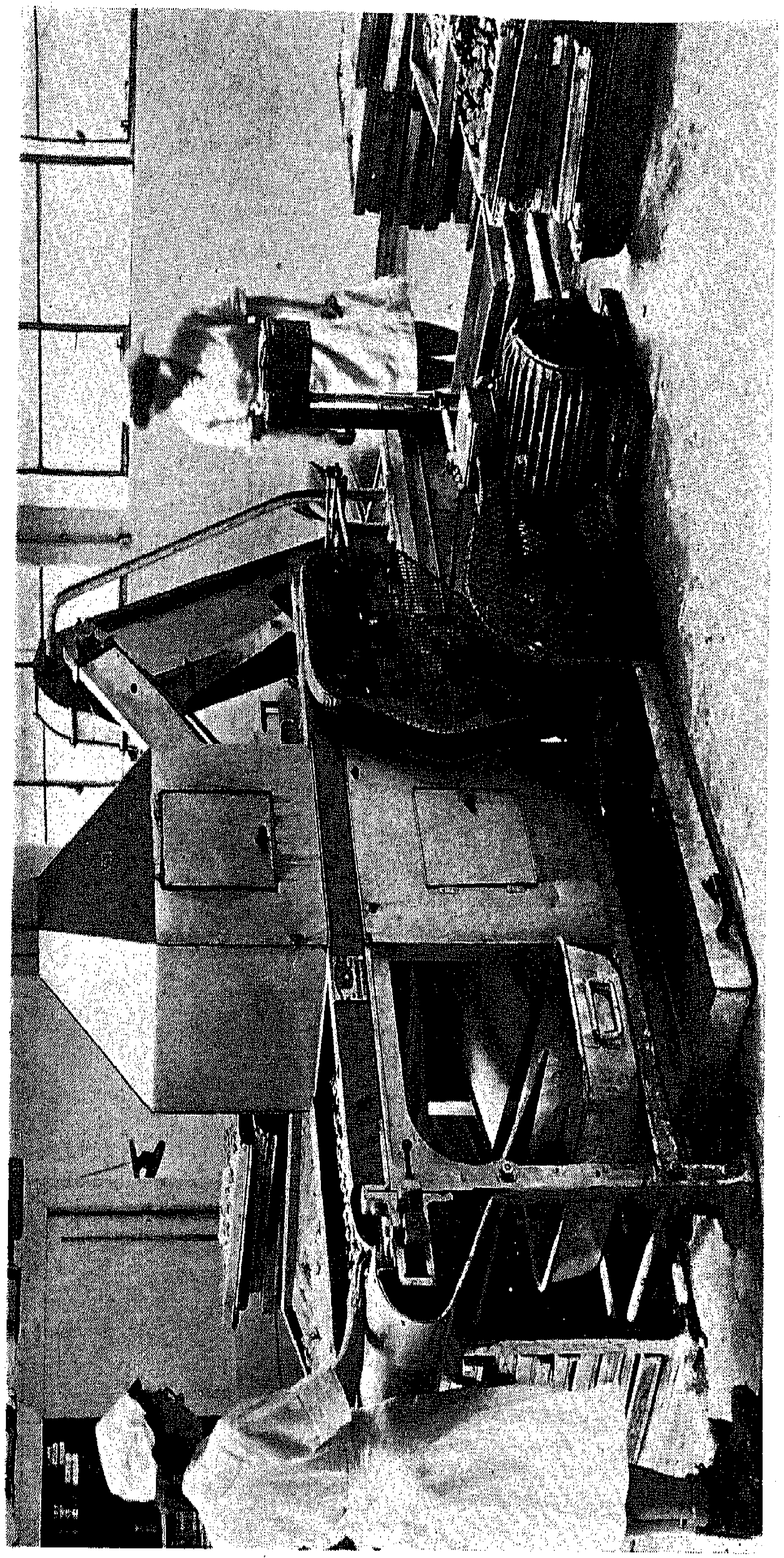


FIG. 48.—B.C.H. GUM CLEANING AND CRYSTALLISING MACHINE.

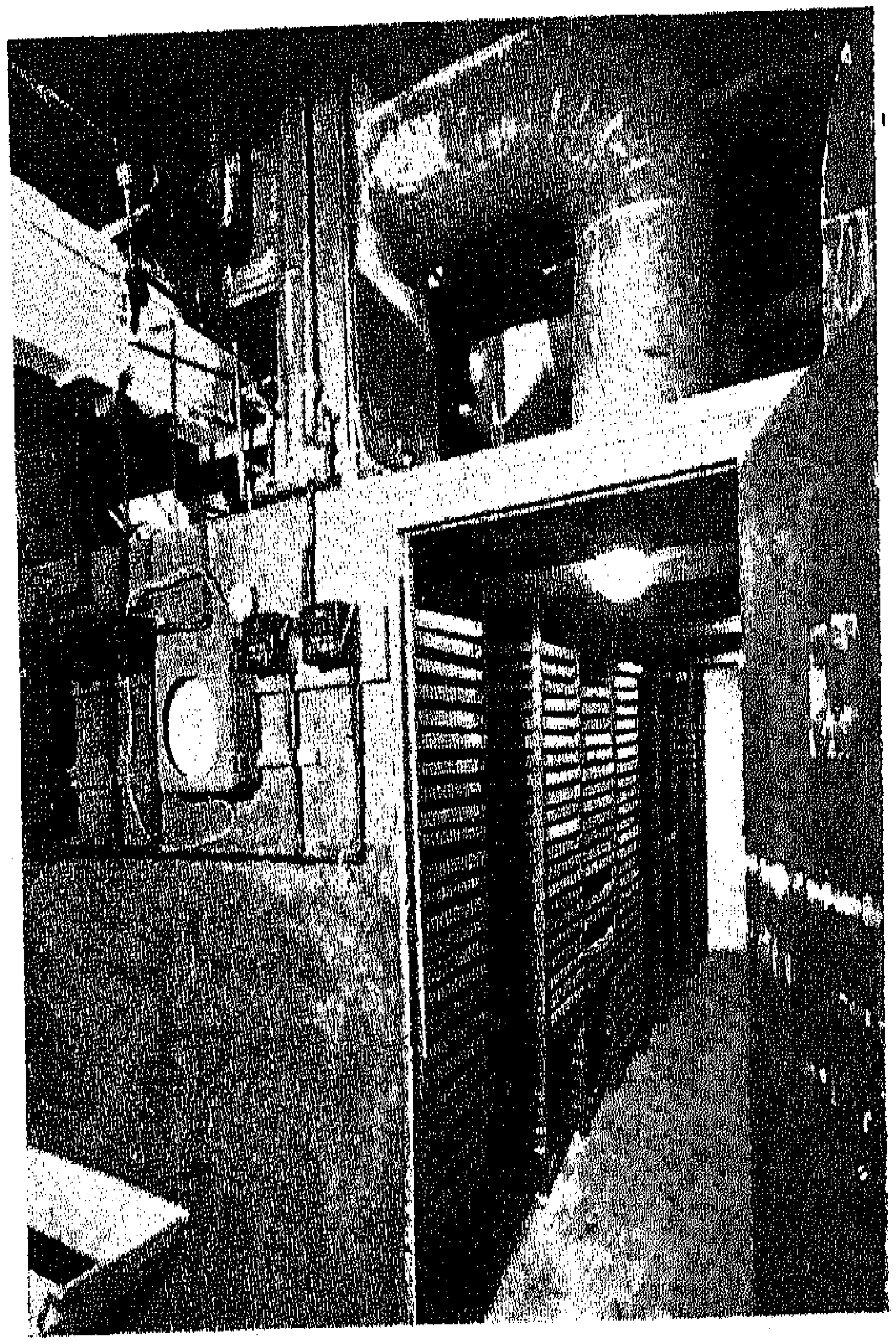


Fig. 49.—Drying Stoves.

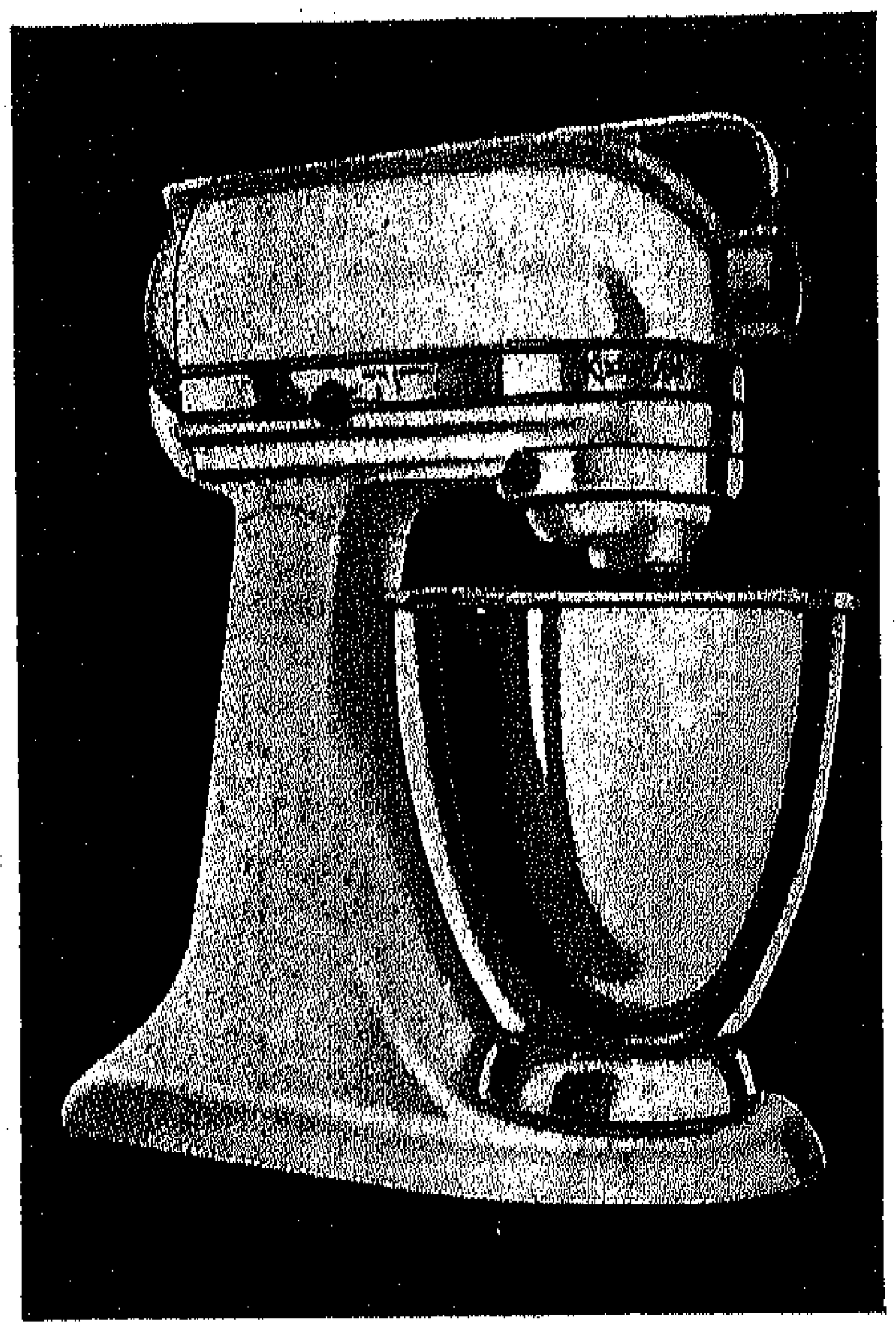


Fig. 50.—Albumen Whisk.

Nougat Frappé

8 oz. of egg albumen is dissolved in 1 lb. of water, and the following cooked to 245°F.:

Granulated sugar	4 lb.
Corn syrup	4 ,,
Invert sugar	4 ,,
Water	1 ,,

4 lb. corn syrup (cold) is placed in the whisking machine, and the cooked batch added. The whole is mixed for 4 minutes, then the albumen solution added and beaten well for 15 minutes. The resultant frappé is used in the following nougat formula.

Nougat containing Soya Protein

The following ingredients are cooked to 266°F.:

Granulated sugar	17½ lb.
Corn syrup	20 ,,
Invert sugar	2½ ,,
Water	3 ,,

The cooked batch is placed in a nougat beater, 10 lb. Nougat Frappé added and beaten for 15 minutes. A mixture of 2 lb. 3 oz. soya protein and 4 lb. 2 oz. hard butter (m.p. 88°F.) is placed in the batch, beating being continued until well mixed, then cut as described for nougat formula.

Malt Nougat

Tate's Grade 20 pieces	15 lb.
Granulated sugar	15 ,,
Corn syrup	22 ,,
Albumen	8 oz.
Malt extract	3 lb.
Hard butter	1 ,,
Powdered full cream milk	1½ ,,
Broken wafer biscuits	1 ,,
Vanillin	1 oz.

The albumen is dissolved in 3 pints of water and whisked to a froth in the whisking machine. The sugar and corn syrup are cooked to 265°F., and the cooked batch placed in a nougat beater. The beater is set in motion and the albumen added. Just before the completion of process, hard butter (melted), milk powder, malt extract, vanillin and wafer biscuits are added and allowed to mix thoroughly. The nougat is poured on oiled and dusted cooling slabs to thickness required and, when firm, cut on nougat knives into bars for chocolate dipping.

This nougat will form the basis of an interesting series of variations for chocolate-coated bars by sandwiching the nougat between caramel layers; by the addition of pecans, walnuts or hazelnuts, or in conjunction with a layer of praline.

Marshmallow (Gelatin)

Granulated sugar	24	lb.
Corn syrup	16	„
Gelatin	1½	„
Water	1	gal.
Vanillin	¼	oz.

The gelatin is pre-soaked in water until pliable.

The sugar, corn syrup and water are placed in a steam pan, the sugar dissolved and cooked to 240°F. The batch is transferred to a marshmallow beater, the gelatin added and allowed to dissolve in the hot solution. The batch is beaten until well aerated, adding vanillin just before finishing point.

The marshmallow is poured into coconut-dusted trays to the required thickness and the surface sprinkled with fine coconut. The sheets are cut by machine and thrown into coconut, so that each piece is completely covered.

If desired, half the above batch may be coloured a delicate pink and poured on the white portion.

Marshmallow (Cast)

Granulated sugar	14	lb.
Corn syrup	7	„
Egg albumen	4	oz.
Gelatin	8	„
Water	5	pints.
Vanillin	⅛	oz.

The albumen is dissolved in ¾ pint of water and beaten to a froth in a small whisking machine. The gelatin is pre-soaked until pliable. The sugar, corn syrup and balance of water are placed in a steam pan and heated until the sugar is dissolved. Gelatin is added and dissolved. The batch is transferred to a marshmallow beater and beating commenced, adding albumen slowly. The mallow is beaten to a light body, vanillin added, and the whole transferred to the hopper of a depositor, heated sufficiently to keep the mallow fluid. If the mallow is too stiff, a little syrup bob of 26° Baumé density may be added.

Marshmallow should always be cast in very warm, dry starch to obviate unsightly crusting. Starch is sieved over the surface to form a thin crust on top of the mallows and the trays set aside overnight. When set, the mallows are cleaned by air-brush and dusted with a 50-50 sugar-starch powder when packing.

Marshmallow (for Chocolate Centres)

Granulated sugar	18	lb.
Corn syrup	9	„
Egg albumen	14	oz.
Dextrose hydrate	2	lb.
Water	8	pints.
Vanillin	¼	oz.

The albumen is dissolved in 2 pints of water in a porcelain bowl and beaten to a froth. The sugar and corn syrup are placed in a steam pan with the balance of the water, the sugar dissolved, and the batch cooked to 236°F. It is then transferred to a marshmallow beater, the shortener, dextrose hydrate, added whilst beating, the whipped albumen added slowly. The mallow is beaten to a light body and vanillin added. The batch is transferred to the hopper of a depositor and cast in very warm, dry starch. Starch is sifted over surface, and the trays set aside overnight to crust. The mallows are cleaned and air-brushed, then coated with chocolate in the enrober.

Schaum Mallow

Granulated sugar	10	lb.
Icing sugar	2½	,,
Corn syrup	3	,,
Farina	4	,,
Gelatin	7	oz.
Bicarbonate of soda	½	,,
Vanilla essence	2	drams.
Tartaric acid	¼	oz.

The gelatin is pre-soaked. The granulated sugar and corn syrup are cooked to 240°F., and the cooked syrup transferred to a marshmallow beater. The soaked gelatin, farina, icing sugar and tartaric acid are added, and the batch beaten until light, adding the bicarbonate of soda and appropriate flavouring essence whilst beating. The mass is cast in impressions in hot starch and stoved lightly overnight. If a syrup bob is used to thin the mallow sufficiently to cast, only an absolute minimum should be used to avoid a breakdown of texture during the drying process.

This type of mallow is usually used for novelty confections.

CHAPTER XI

DRAGÉES

Technique

The principle of dragée work is the progressive deposition of sugar from a supersaturated sugar solution upon the surface of the goods to be coated.

The successful production of dragées, the generic title given to all goods coated with sugar in revolving pans, requires a high degree of craftsmanship and invariable attention to details during manufacture. The process of hard panning is a long one, and varying atmospheric conditions on successive working days may cause slight modifications of procedure to be adopted by the operator to ensure the perfect building up of sugar coatings on his goods. So much depends upon the knowledge of the operator as to the exact points of application of sugar syrup, the addition of powdered sugar or other ingredients, and the degree of heat required to dry each charge. He must adjust his process when dealing with centres containing fats or oils, such as nuts, chocolate centres, coconut candies, so that such oils are not extracted in process and react adversely on his coatings. Special preliminary coatings of gum must be added to liquid centres to prevent breakage in the revolving pan. The operator must be fully conversant with the correct application of filtered hot and cold air currents, which are supplied throngh air ducts leading into the revolving pans, so that he obtains the highest possible degree of finish to his dragées; the warm air accelerates the drying process, cold air would be used when coating with fats or chocolate.

The care and attention needed for the production of dragées is more than justified by the pleasure experienced by both producer and consumer at the sight of the delicate, high-class appearance of the finished dragées.

Formulæ and Processes

Sugared Jordan Almonds

Selected Jordan almonds ..	80 lb.	
Gum arabic (finely powdered)	8 „	dissolved in 1 gal. of water.

Gumming.—The first stage is the gumming of the almonds to prevent exudation of the oil in the nuts.

The almonds are carefully sifted, brushed and sorted to eliminate all bad shapes and extraneous matter, then placed on clean trays in the drying room, which must not be hot enough to cause exudation of oils or cracking; 80°-90° is sufficient.

The gum is soaked in water overnight, and finally warmed gently and stirred to dissolve the gum. The mucilage is passed through a hair sieve to remove extraneous matter and undissolved gum.

The cold pans are charged with the almonds, and the gum solution ladled over them until each nut is adequately covered. At the end of this process, a little finely powdered sugar is added to separate the almonds. The latter are sifted and replaced in the revolving pan, which is now slightly warmed to assist drying. When the gum coating is thoroughly dry, further gum solution is added to give an even coat; finally, the goods are sifted into trays and placed in the drying stove to complete hardening.

Grossing and Bulking.—The second process of grossing and bulking serves to create the main body of the coating.

A solution of best white sugar is made in water, with the aid of a gentle heat, until the syrup shows a density of 36° Baumé. A quantity of this syrup is mixed with an equal volume of the gum mucilage and poured gradually over the dried, gum-coated almonds now replaced in the warm dragée pan. Sufficient syrup is allowed to cover the almonds without under or over drying, and the hand passed through the almonds to facilitate covering, but only until the almonds begin to dry. At this point, a charge of finely powdered sugar is added, and the almonds allowed to run until they are well covered and dry.

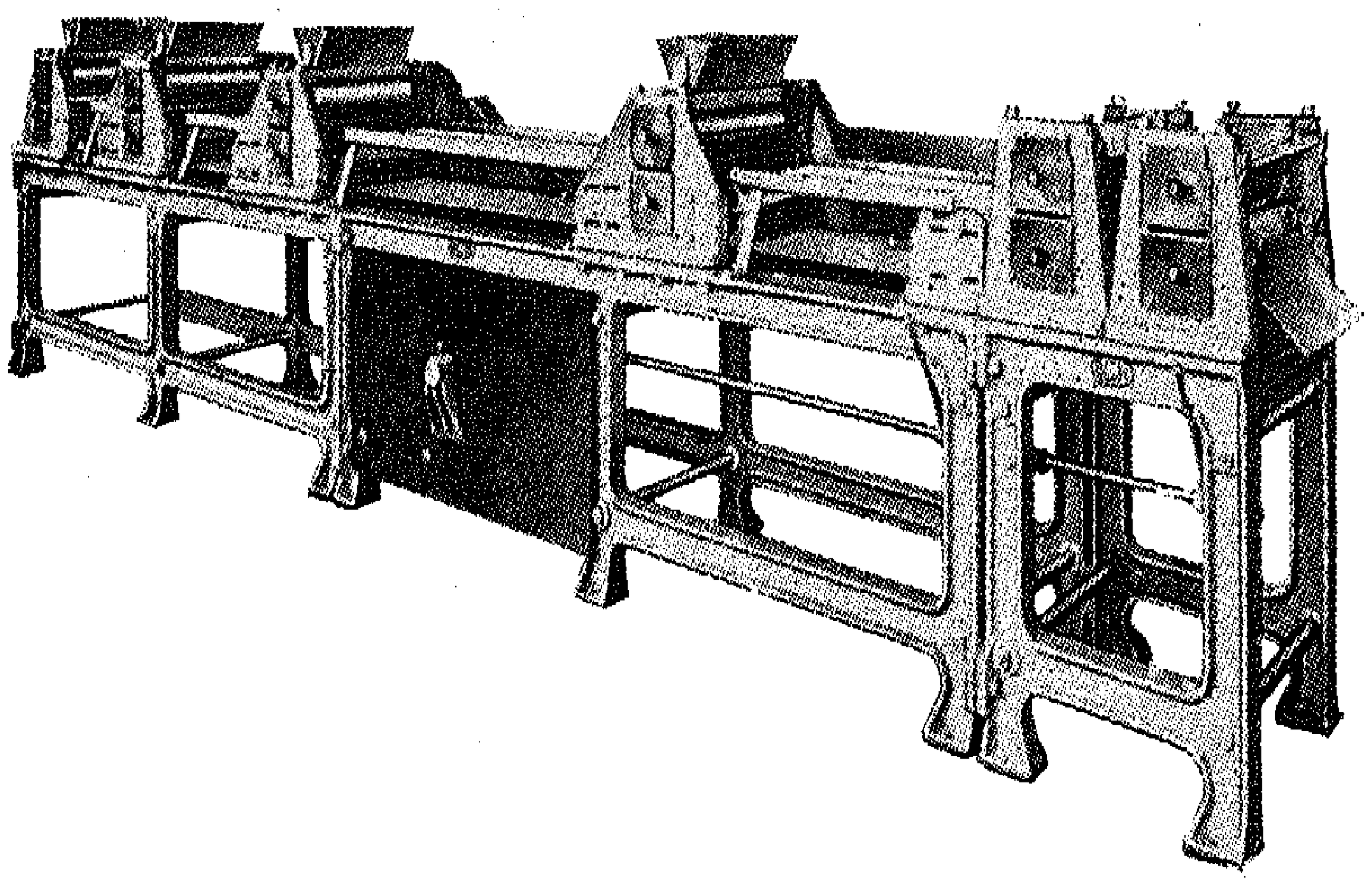


Fig. 51.—B.C.H. Chewing Gum Cutting Machine.

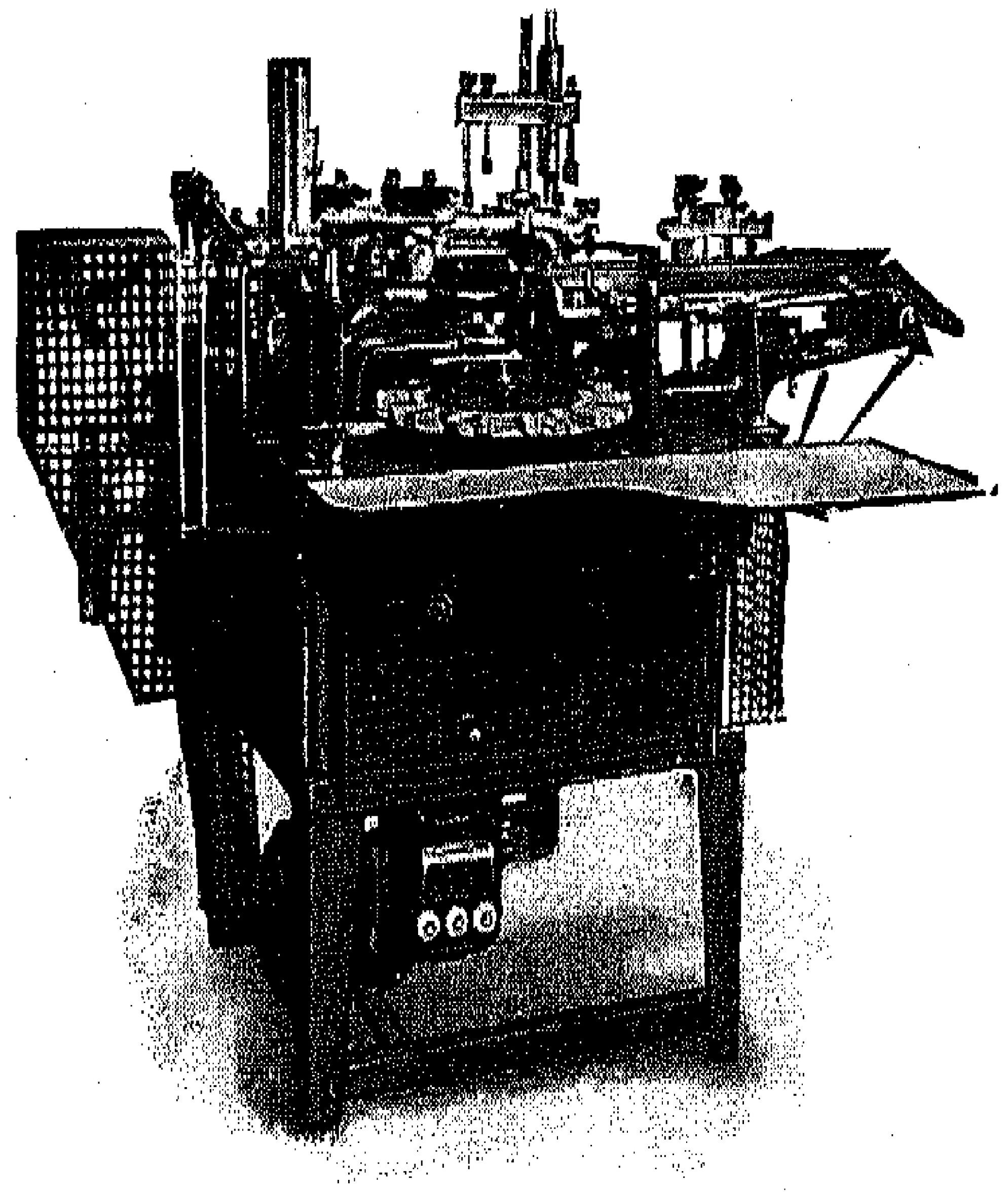


Fig. 52.—Lauenstein Universal Foiling Machine.

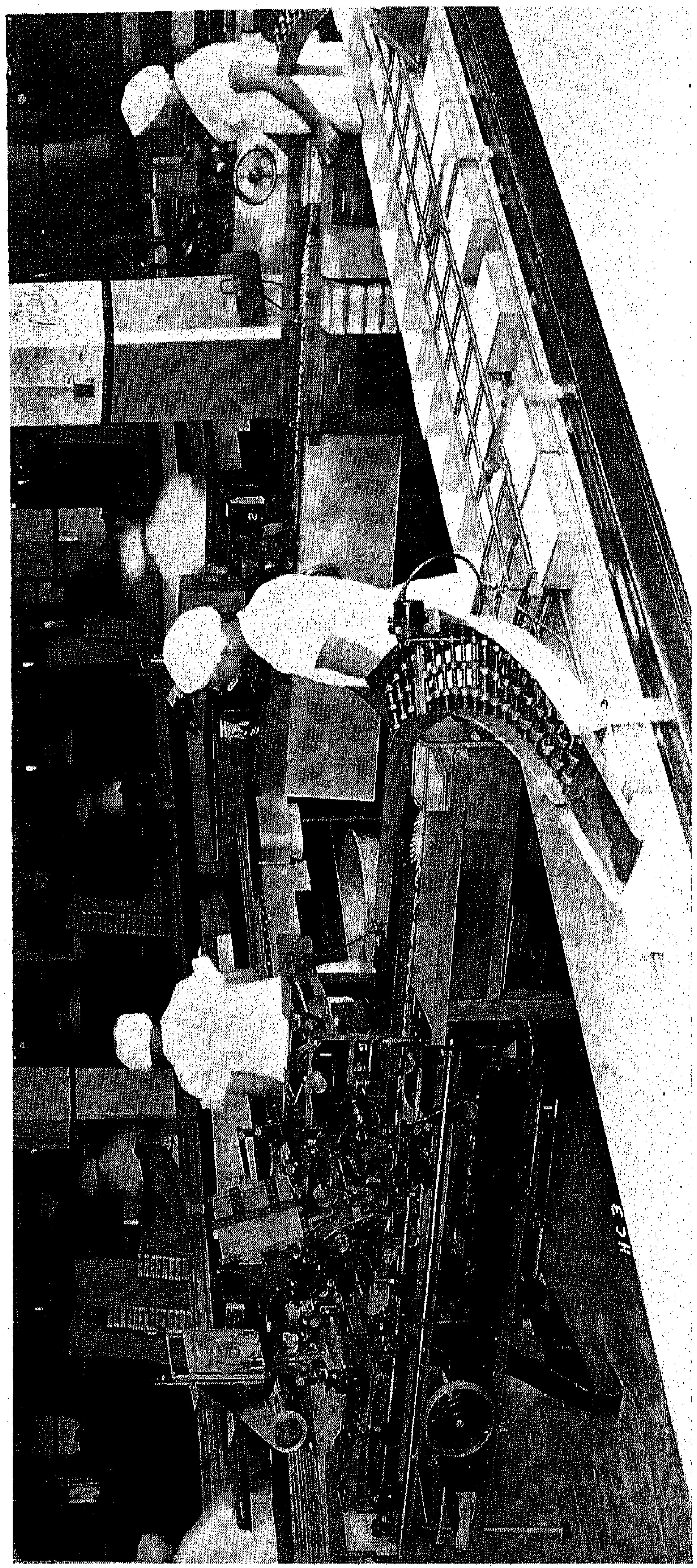


FIG. 53.—BATTERY OF BAR FOILING MACHINES.

Another charge of 3 : 1 sugar-gum solution is added, and, near drying point, a further charge of powdered sugar. The almonds must be well dried. The subsequent four charges are made with the 36° Baumé sugar syrup only, allowing each charge to dry thoroughly. The next charge is a sugar syrup with a 5 per cent. addition of gum solution. At this stage the almonds are inspected to ensure absence of pin holes. Should these appear, the heat is discontinued, and sugar-gum solution added, assisting the coating by passing the hand through the mass, then dusting with powdered sugar. The almonds are thoroughly dried, sifted and placed in the warm stoves to complete drying. The number of charges of syrup depends on the ultimate size of sugared almond required.

Whitening.—The third stage in the process is whitening. At this point, the almonds are beginning to take on thinner coatings of sugar, which have the effect of increasing the whiteness of the individual pieces.

A solution of best white sugar in water is made to give a density of 33° Baumé. The warm dragée pan is recharged with the now thoroughly dry almonds, and a charge of warm syrup added. It should be noted that very hot syrup should not be used, otherwise split coating will result. Between each charge, the almonds must dry perfectly to the point of dusting. For completion of the whitening process, the final four or five charges of syrup should be made at a density of 30°-31° Baumé. At the end of the process, the almonds are sifted and placed in a warm stove to complete drying.

Filling.—The fourth process is filling, in which a lighter syrup is now added to fill out the exceedingly small depressions on the surfaces of the coated almonds.

A sugar solution of 26° Baumé density is made. The almonds are placed in a cold dragée pan and charged with sufficient syrup to secure uniform covering, using the hand to assist the process. When the almonds begin to dry, the steam is turned on and the goods gently heated. When the almonds dust well, heat is turned off and the dragées cooled. This process is repeated for six or seven charges, until the almonds are well filled. The sifted almonds are then transferred in trays to the drying stove.

Polishing.—The fifth stage is polishing. For this process, a sugar syrup of 30° Baumé density is prepared and allowed to cool. The almonds are placed in a clean dragée pan, and charged with the syrup, allowing each charge to dry completely before adding a further charge. The last three charges are made with diminishing quantities of slightly lighter densities of syrup (28° Baumé). The filtered colouring, which must naturally be very delicate, is added in the final charges of syrup. At this point the pan is heated moderately until the almonds are uniformly warmed and begin to dust. They are transferred to trays, placed in a warm stove (100°-110°F.) and allowed to dry. Final inspection for poor shapes and imperfectly coated pieces completes the operation.

Usually the centres for chocolate dragées consist of a mixture of various types of nuts, moulded pulled sugar goods, and praline. For highly finished goods, it is important to ensure complete covering of the irregular-shaped centres to prevent sweating of the centre and to give a smooth appearance.

Chocolate Coated Dragées

8 lb. gum is melted in 1 gal. of water in a steam pan, and the mucilage passed through a hair sieve. At the same time, a sugar syrup of 36° Baumé is prepared.

The centres are replaced in a warm dragée pan and a mixture of three parts of sugar syrup to two parts of gum mucilage is added and the centres coated thoroughly, drying with cocoa powder applied liberally. This process is repeated until the desired thickness of coating is obtained. The final stages of polishing are assisted by allowing an air blast to play on the revolving goods, which for this process are transferred to a clean, cold dragée pan.

Alternatively, centres may be coated with sweetened chocolate in the dragée pan. This is accomplished by first melting the chocolate in a kettle, tempering to 88°F. and pouring on the centres slowly in a water-cooled pan.

Glaze for Chocolate Dragées

A convenient quantity of gum benzoin is dissolved in sufficient alcohol to bring about perfect solution, and an equal weight of sugar-cacao butter mixture (1 : 1) added. The solution is slightly warmed to dissolve the sugar and butter, adding more alcohol if too thick. The glaze is carefully applied to the coated goods in a clean pan, and the centres allowed to run until dry.

Silver Dragées

The process of silvering or gilding dragées is not an easy one, and requires meticulous attention to operational details, as there is very little margin between success and failure. The silver or gold leaf used must be 100 per cent. pure and extremely fine, so that the centres can take up the metal smoothly. A warm and dry department is essential for this process.

The basis or centre for silver dragées is built up in dragée pans from granulated sugar, which is subjected to successive coatings of gum-sugar syrup until the required size boule is obtained.

These boules are produced in a range of sizes according to the decorative effect required by the baker-confectioner, who is the chief customer for this class of merchandise. The following table shows the approximate diameter and the quantity of silver leaf required to coat each size.

RELATION OF COATING QUANTITY TO SIZE OF BOULE

Designation of Boule.	*Diameter.*	*Amount of Silver Leaf Required per 14 lb. of Centre.*
000	1·6 mm.	3 oz.
00	2·4 mm.	$2\frac{15}{16}$,,
0	3·2 mm.	$2\frac{3}{4}$,,
1	4·0 mm.	$2\frac{1}{2}$,,
2	4·8 mm.	$1\frac{3}{4}$,,
3	5·5 mm.	$1\frac{1}{2}$,,
4	6·4 mm.	$1\frac{1}{4}$,,
5	7·0 mm.	$1\frac{1}{8}$,,

In practice, small sizes of boules are polished with the larger, and this applies to bean or other shapes, which have a core of moulded pulled sugar coated with successive coatings of gum-sugar syrup. The separation of these different sizes of boules is made by using copper sieves of varying mesh.

Process for Silvering Dragées

First, 2 lb. 4 oz. best white leaf gelatin is soaked until it loses its brittle state. The gelatin is added to 9 pints of 35 per cent. acetic acid in a porcelain bowl, and dissolved with a very gentle heat. This stock solution is stored in a tightly sealed earthenware jar in a cool place until required.

The proportionate amount of silver leaf, according to the size of the boule being processed, is placed in the glass revolving bowl. The sugar boules are moistened with the gelatin-acetic acid solution, just sufficiently to cover without excess; this point is extremely important, and much of the success of the coating process depends on the care exercised. The moistened boules are scooped into the glass pan and the latter set in motion at a fairly fast speed. The covering process takes about 2-3 hours. After covering, the silvered dragées are allowed to stand for some time in tightly lidded metal containers, to allow the further drying of the coating. The containers prevent air and light affecting the silver coating. It is usual to polish the silvered dragées just prior to despatch, so that they are at their brightest when received by the customer. To polish the dragées, they are placed in a clean glass revolving bowl which revolves at a higher speed than the coating bowl, and the dragées allowed ample time to acquire a highly polished surface. All silvering and gilding processes are carried out cold, sufficient heat being generated by the friction of the boules to cause evaporation of the gelatin-acetic acid solution used.

Lower Grades of Dragées

Cheaper grades of dragées are produced by using a percentage of corn- or rice-flour in conjunction with the gum-sugar syrup during the bulking process. The goods so produced do not possess the brittle character of all-sugar coated dragées, and the effects of the flour used cannot be entirely masked by the addition of essences. Although dragées such as aniseed balls and kindred types are extremely popular in tropical countries, it is unwise to use flour in the manufacture of such goods for export to these countries, since there is a tendency under tropical conditions for flour-containing pan goods to develop

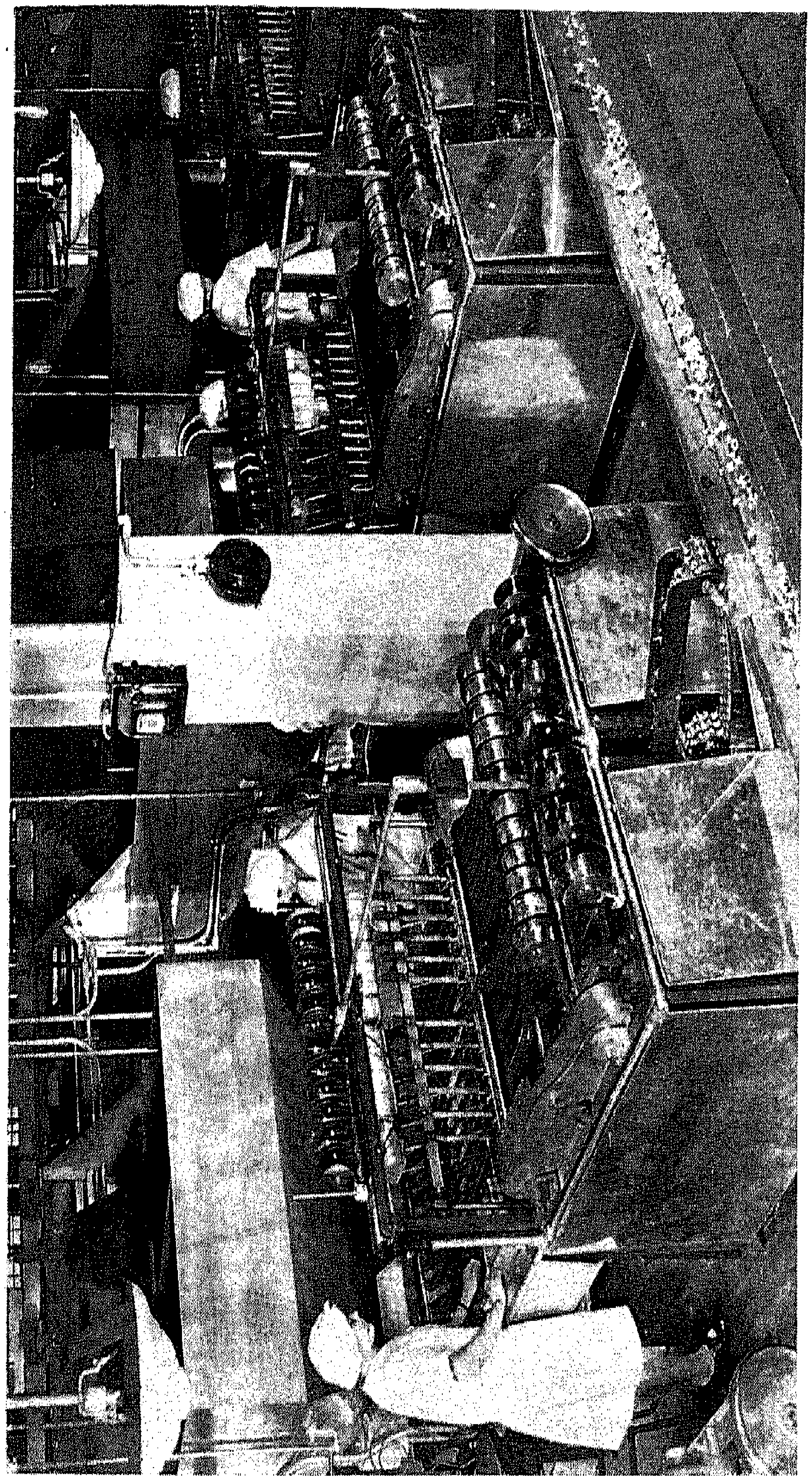


FIG. 54.—BATTERY OF FOIL WRAPPING MACHINES. (Note Hopper charging mechanism.)

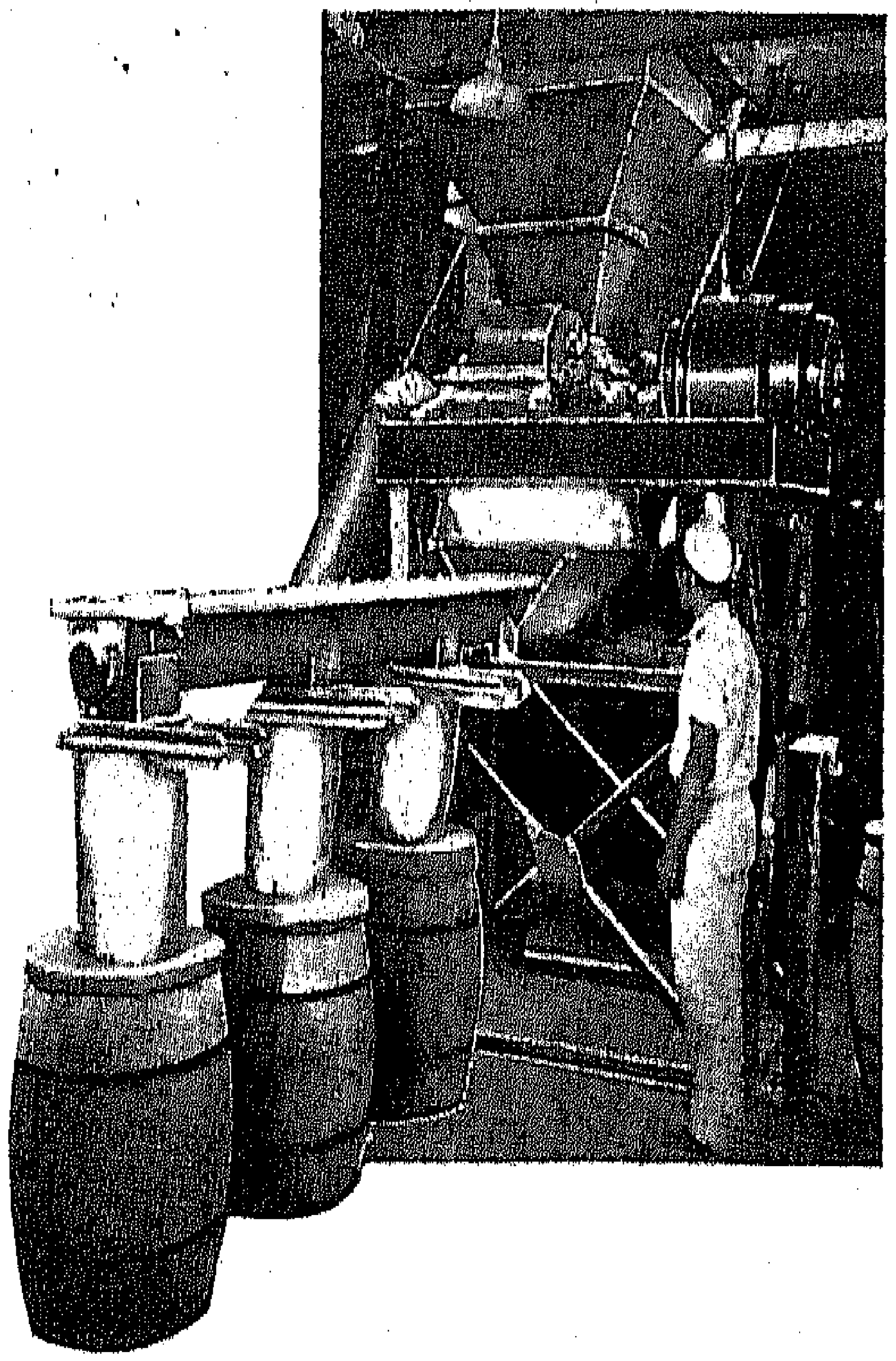


Fig. 55.—A Good Example of the Simplicity of a 3 TH Mikro-Pulverizer Powdered Sugar Installation in a Large Candy Plant.

(A one-floor arrangement, using a bucket elevator to the feed bin and a screw conveyor for filling barrels.)

Fig. 56.—Hard Candy Sorting Department.

micro-organisms, which feed on the sugar content and give the dragées a pitted appearance.

Soft Sugar Coating

The soft-coating of a variety of centres is accomplished by the use of sugar-corn syrup solution of 34° Baumé and liberal applications of powdered sugar. Coconut paste, praline, fondant cream and caramels may be treated by this method.

Soft coating is a cold process. The goods such as jelly beans are placed in a dragée pan and a corn-syrup solution of 34° Baumé is added in sufficient volume to cover the goods in motion without excess; a charge of caster sugar is added to prevent pieces adhering. The goods are allowed to revolve until they become somewhat tacky, then a further charge of caster sugar added, repeating this process until the goods dry. A further charge of syrup, which has now been coloured as desired, is added and the addition of sugar, but of a finer grade, repeated until the goods begin to dust. The operation is completed with a charge of finely ground sugar, keeping the pan in motion until the dragées are quite dry and smooth. Soft-coated goods are allowed to stand to cool and dry overnight before returning to the dragée pan for glazing with beeswax or spermaceti.

Hard Butter Method

Another method of soft-coating centres such as nougat balls and various types of nuts is to coat with a hard butter, previously melted and applied to the centres in the cold dragée pans in the same way as sugar syrups. As soon as the centres are equally coated with the fats, liberal applications of powdered sugar are quickly added, the goods allowed to run until the bulk of the sugar has been assimilated. During the whole of the process, cold air is directed into the pans through the air ducts to assist solidification of each charge of fat. This process is repeated until the desired size of sweet is attained, then the goods are lightly sieved and packed in waxed-paper lined packages.

Polishing

A method of polishing certain types of dragées, where frictional polishing alone will not attain the desired degree of brilliance, is by the use of spermaceti and beeswax. This method depends on placing several small blocks of the wax in the cold revolving pan containing the dragées to be treated, and allowing the goods to acquire a thin surface of wax by abrasion.

Nonpareils

1-1½ cwt. of well-dried and sifted granulated sugar is placed in a steam-heated dragée pan. The sugar is warmed and maintained at a gentle heat throughout the process. A liberal charge of 26° Baumé syrup is poured over the sugar in motion, and the hand run through the mass to distribute the syrup evenly, sprinkling with a scoop of warm corn starch. The mass is well agitated with the hand. This process is repeated until the grains begin to take form. At this stage, 30° Baumé syrup and corn starch are added for several successive charges. Then the process repeated with 35° Baumé syrup and corn starch until the grains have increased nearly sufficiently. Finally, charges of 35° Baumé syrup alone are added. Each coating is allowed to dust before adding the next charge of syrup. Finishing is accomplished by adding 4 or 5 charges of syrup at 32° Baumé, to which is added the desired colourings.

Pearled Goods

Glacé fruits, cinnamon chips and carraway seeds are examples of the centres usually employed in producing pearled goods. Pearling may be applied to any type of centre, and is accomplished by allowing a continuous stream of sugar syrup and gum arabic solution to fall on the centres revolving in a heated dragée pan.

The centres are previously coated with gum solution to provide a firm base upon which to work, then bulked with sugar syrup until the desired size is obtained. They are ready, after drying in warm stoves, to be returned to the dragée pan for the pearling operation.

Method of Pearling

A sugar syrup of 36°-37° Baumé is prepared. 7 lb. gum arabic is dissolved in 1 gal. of water and strained through a hair sieve. The sugar syrup and gum solution are mixed in the proportion of 3 : 1. A quantity of this mixture is transferred to the pearling pot suspended over the aperture of a dragée pan. A suitable amount of centres, already gum-coated and bulked, are placed in the pan, which is allowed to revolve, and the steam turned on. The rod of the pearling pot is adjusted to give a steady thin stream of syrup-gum solution on the heated goods. *Do not force the operation.* The goods are taken out when dry, placed in a warm stove overnight to harden, and the process repeated the following day, until the pearl has reached the desired volume. Finally, when dry, the pearled goods may be coated with gum arabic solution, or gum benzoin-alcohol solution, to give them a glaze. Colourings are added to the syrup if required.

Imitation Rose and Violet Petals

Rose Petals.		*Violet Petals.*	
Tapioca flakes ..	28 lb.	Tapioca flakes ..	28 lb.
Granulated sugar	60 ,,	Granulated sugar	60 ,,
Otto white rose ..	7 drams.	Otto heliotrope ..	7 drams.
Rose pink colour	7 ,,	Heliotrope colour	7 ,,

The colour is dissolved in a little hot water and filtered. This colour solution and the otto are added to 3 pints of gum arabic-sugar syrup (50-50) mixture. Sugar syrup at 32° Baumé.

The tapioca flakes are placed in a cold dragée pan, and the coloured syrup slowly added to cover the flakes as evenly as possible. A liberal charge of sugar is added and the goods allowed to run until dry. The process is repeated until the flakes are well encrusted with the sugar, then the flakes are taken from the pan, placed in trays and transferred to a drying room. They are inspected for bad shapes when dry. These imitation floral petals are useful for the decoration of chocolates, fourrés and bakery products.

CHAPTER XII

LOZENGES AND CREAM PASTE

THE manufacture of lozenges and cream pastes is one of the oldest arts known to mankind, since the pastes are formed by a simple kneading process (Fig. 66). The essence of good paste production lies in the mixing, during which the mass is subjected to a certain amount of aeration, resulting in a light, easily assimilable product. Formulæ for lozenge or cream pastes can be varied to a considerable extent, providing always that lozenge pastes contain an adequacy of cohesive agent such as gelatin or gum tragacanth to prevent crumbling, and, in the case of cream pastes, a sufficiency of invert to prevent excessive loss of contained moisture.

Cream paste containing an excess of invert becomes damp and soggy. To obtain a smooth eating lozenge or cream paste, the ground sugar used to bulk should be refined to 35 microns or less.

LOZENGES

Formulæ

Good Quality Mint Lozenges

Finely ground sugar	108 lb.
Gelatin	1 „
Powdered gum tragacanth	4 „
Mitcham peppermint oil	6 fl. oz.

The gum tragacanth is placed in 2 gal. of cold water in a whisking machine and beaten until a good mucilage is obtained. This mucilage is passed through a fine sieve into a U-shaped mixing machine. The previously soaked gelatin is dissolved in a little warm water and added to the gum. The machine is put in gear and the ground sugar added, allowing each charge to mix thoroughly before adding the next. Sugar is progressively added until the final dough or paste can be handled without sticking. Finally, the peppermint oil is added and allowed to mix in thoroughly. The paste is discharged on to a dusted slab, preparatory to feeding into the hopper of the lozenge-cutting machine. The trays containing a single layer of cut lozenges are placed in the drying room at a temperature not exceeding 80°-90°F. If the temperature of the drying room is too high, the volatile peppermint oil will evaporate and spoil the product. A mobile current of dry warm air is the correct drying medium for all lozenge work.

When the lozenges are dried and hardened, they should be sieved and brushed carefully, then packed in well-sealed packages to prevent loss of flavour.

Cheap Mint Lozenges

Finely ground sugar	140 lb.
Gelatin	2 „
Farina	28 „
Gum tragacanth	4 „
Wayne County peppermint oil	8 fl. oz.

This is processed as described for previous formula, adding the farina (potato starch) with the sugar.

Linseed Licorice and Chlorodyne Lozenges

Finely ground sugar	224 lb.
Licorice juice	10 „
Gum arabic	12 „
Gum tragacanth	4 „
Chloroform-ether (4 : 1)	13 „
Medium grade peppermint oil	1½ fl. oz.
Capsicene	1 „
Aniseed oil	1 „
Linseed oil	4 „

The procedure is exactly as described in Peppermint Lozenge formula, ensuring that all the stated precautions against loss of volatile constituents are taken during the drying period.

Compressed Lozenges

8 oz. of white stearine is dissolved in 2 pints of alcohol, and a solution of 3 oz. gelatin and 2½ pints water is prepared.

Both liquids are placed in a U-shaped mixing machine, and 62½ lb. of finely powdered sugar added. The resultant mass is sieved and dried in a current of warm air, and finally placed in a Gardner powder mixing machine, and 3 oz. of peppermint oil or other flavour added as desired. The powder is compressed into tablets on the compressing machine.

Gelatin and stearine act as the cohesive agents in compressed lozenges.

Perfumed Cachous

Finely ground sugar	60 lb.
Gum tragacanth	4 ,,
Tartaric acid	3 oz.
Gum arabic	4 lb.
Gelatin	12 oz.

The cachou paste is processed exactly as described for lozenge paste. The paste is coloured and flavoured in the mixing machine. The mass is rolled into thin sheets and cut, according to the design required, on a cachou-cutting machine. The filtered liquid colours must be sparingly used to achieve a delicacy of tint in the cachous.

Perfumed cachous are usually packed in mixed colours and flavours, the following list showing the amount of typical floral attars required to 112 lb. of cachou paste:

Parma violet	28 c.c.
Jockey Club	21 ,,
Opoponax	14 ,,
Attar of rose (diluted)	21 ,,
Honeysuckle	28 ,,
Heliotrope	14 ,,
Lily of the valley	28 ,,
Wood violet	28 ,,
Jasmine	28 ,,

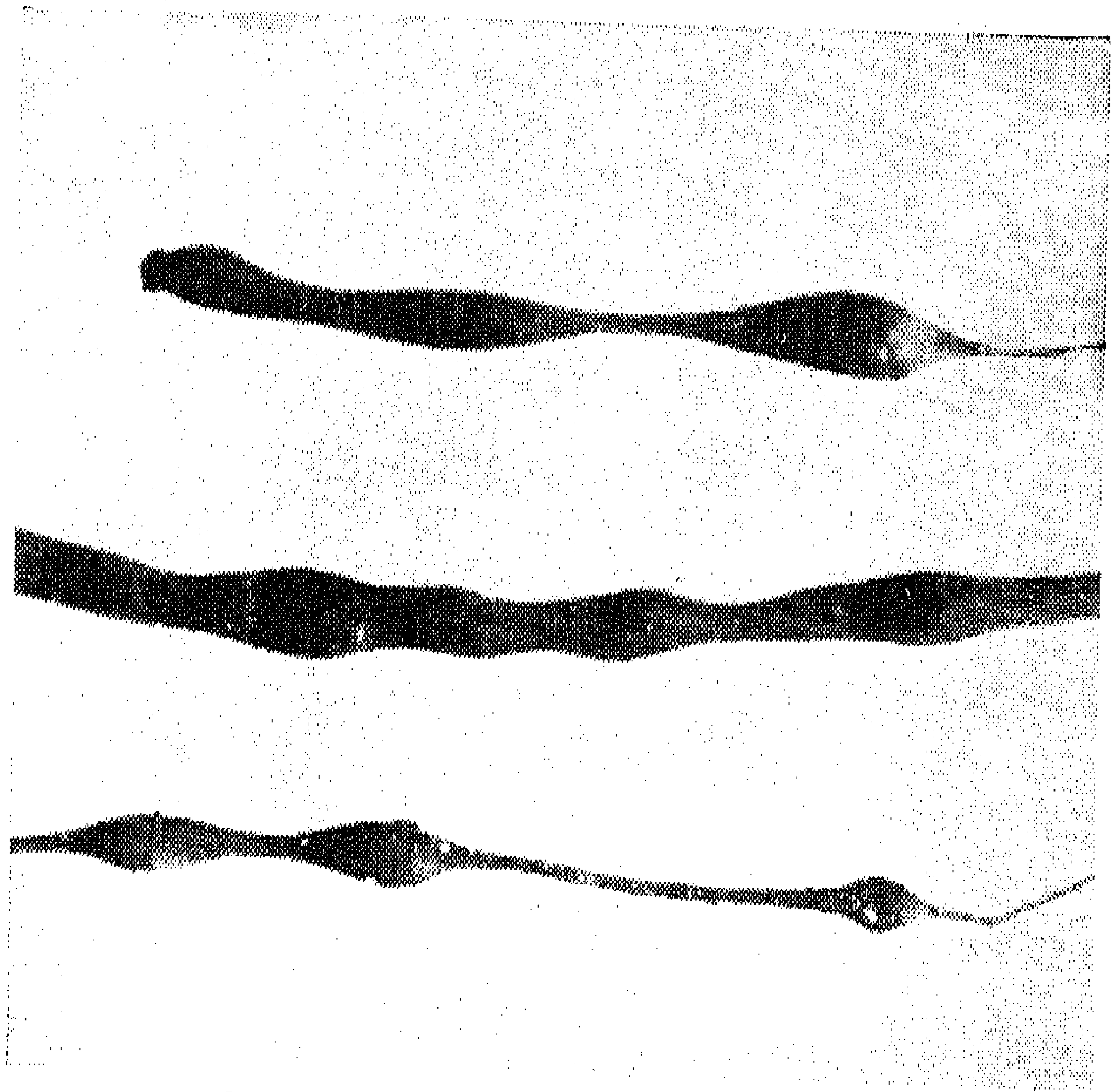


FIG. 58.—DISEASE IN CACAO TREES.

FIG. 57.—NATIVES EXTRACTING BEANS.

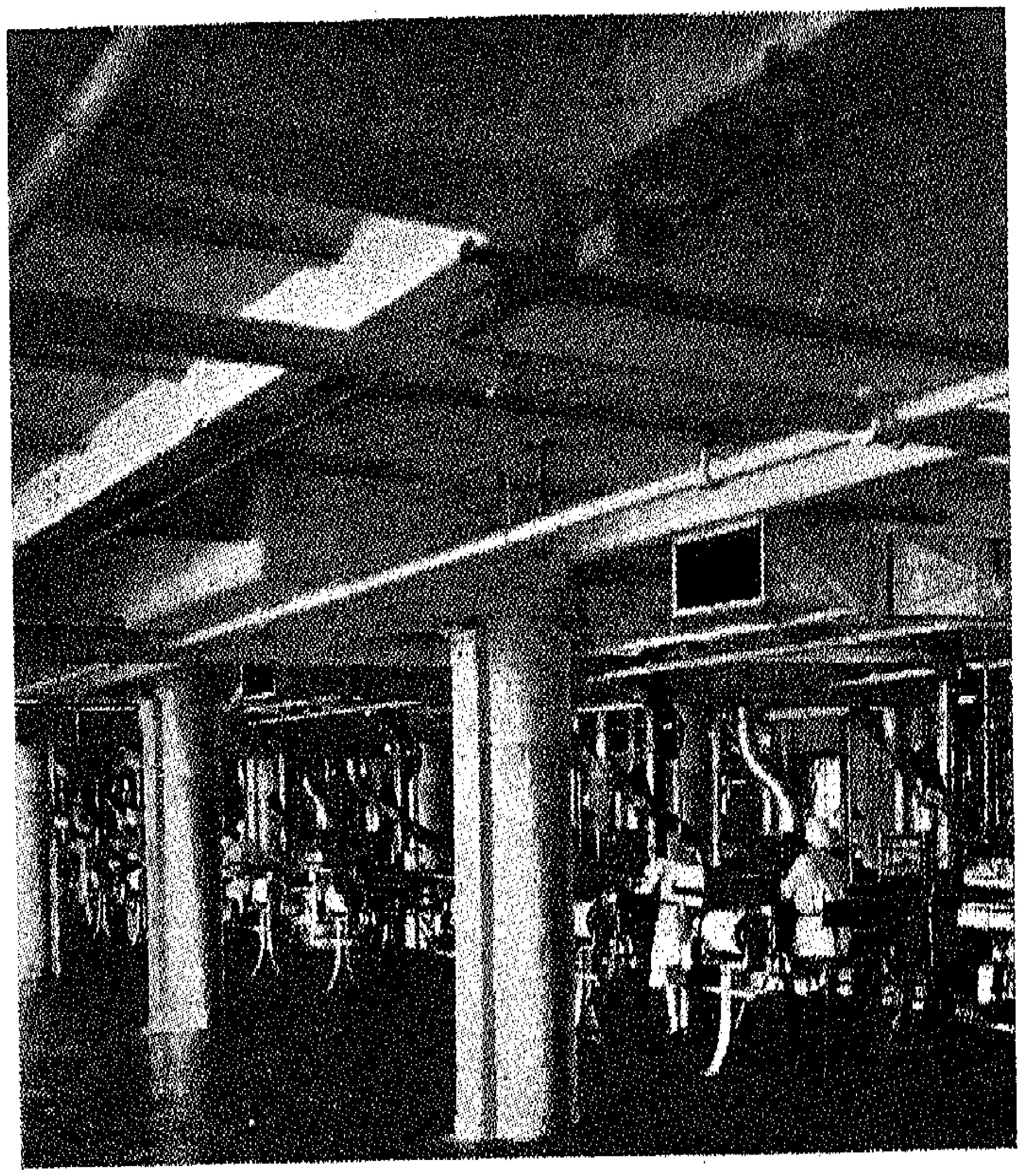


FIG. 59.—ENROBER ROOM.

FIG. 60.—SEMI-AUTOMATIC MACHINE FILLING MOULDS WITH PREDETERMINED WEIGHT OF CHOCOLATE.

CREAM PASTE

Formulæ

Cream Paste

Granulated sugar	28 lb.
Corn syrup	18 „
Hard fat	1 „
Gelatin	3 „
Farina	2 „
Finely ground sugar	35 „

Colour and flavour as required.

The gelatin is soaked in cold water until pliable.

The granulated sugar and corn syrup are placed in a steam pan and, after dissolving the sugar completely, cooked to 236°F. The batch is transferred to a U-mixing machine, and the soaked gelatin and fat, which will dissolve in the hot liquid, are added. The machine is set in motion, ground sugar and farina added until a firm paste is obtained. Flavour and colour are added sparingly. The paste is transferred to a well-dusted slab and covered with a damp cloth to prevent case-hardening. A portion is passed through the sizing brake to required thickness and cut on a guillotine.

When used for licorice allsorts, the paste is rolled to about ⅛ in. thickness, licorice sheet being sandwiched between paste, the sheets being lightly moistened with gelatin syrup to bind them together. The sandwiched sheets are laid on lightly dusted trays, which are stacked in a dry place, to harden sufficiently to cut into pieces on the guillotine.

The incorporation at the mixing stage of 10 per cent. plastic coconut to cream pastes adds body, improves the flavour and texture, and helps to bind moisture in the paste.

Cream Paste (Uncooked)

Caster sugar	16 lb.
Corn syrup	14 „
Icing sugar	28 „
Gelatin	½ „
Lemon essence	¼ fl. oz.

The gelatin is soaked in water until pliable. The corn syrup is heated in a steam pan, the soaked gelatin added and dissolved. The solution is transferred to a U-mixer, caster sugar and icing sugar added gradually until a smooth paste is obtained. Standardisation of the end-point can be accomplished by making a test weight of finished batch. All cream paste batches may be produced to comply with this standardised weight, given constant materials. The paste must neither be tacky nor too dry to the touch.

Final manipulation of the paste is similar to that described for previous cream paste formula.

Coconut Paste

Granulated sugar	28 lb.
Corn syrup	35 „
Water	1 gal.
Desiccated coconut	42 lb.
Vanillin	½ oz.

The sugar and corn syrup are placed in a steam pan with the water and boiled, stirring to dissolve the sugar, then cooked to 240°F. The batch is placed in a U-mixer and coconut added gradually, then the vanillin. After allowing to mix well, the batch is transferred to a caster-sugar dusted slab, cooled somewhat and passed through a sizing brake to a thickness of ½ in. When the rolled sheets are firm, they are cut on a guillotine into pieces, or stamped out into circular patties. The pieces should be dusted well in caster sugar, dried and packed between waxed-paper layers in the containers.

Coconut Nuggets (Toasted)

White granulated sugar	14 lb.
Corn syrup	40 „
Tate's Grade 30 pieces	14 „
Desiccated coconut	45 „
Water	1 gal.
Vanillin	½ oz.
Salt	2 oz.

The sugar and corn syrup, dissolved in water, are cooked to 240°F. and processed as in the previous formula. Drained or dry fruits and nuts may be added if repuired. To toast coconut paste, the cold sheets are placed under a gas grill and toasted lightly, cooled and cut on a guillotine. They are finally packed between waxed paper divisions in containers.

When cut into small squares, this coconut paste may be placed in dragée pans, dusted with powdered gum arabic, and finally soft sugar panned as described in Chapter XI.

LICORICE PASTE

Heavy duty plant is necessary for the production of licorice paste. The masses involved and the tough character of the paste in its final stages place a great strain on the mechanism employed.

The whole process of licorice paste manufacture depends on the proper gelatinisation of the wheat flour used to provide the bulk. If the starch is insufficiently processed, the final product becomes dry and rough. The gelatin acts as a binding agent, and the wheat flour provides the right degree of elasticity to the licorice.

Formulæ

Licorice Paste

Wheat flour	28 lb.
Corn syrup	7 „
Gelatin	10 „
Raw sugar	14 „
Licorice juice	5 „
Caramel (burnt sugar)	14 „

The gelatin is pre-soaked until pliable. The raw sugar is dissolved in 2 gal. of water in a steam pan, the broken licorice juice added and dissolved. This solution is strained to eliminate foreign bodies and lumps. The strained solution is placed in a steel stirring cooker, corn syrup added, and the soaked gelatin dissolved in the batch. The cooking is commenced, and the flour added slowly to allow gradual gelatinisation to take place without lumping. Cooking is continued until a medium ball texture is obtained in a cooled test piece. The cooked batch is passed through the licorice refiner to eliminate lumps, and then transferred to the extruding machine. The extruded sheets or rods are placed in iron trays in a well-ventilated drying room with constant moving air and allowed to dry until the material has lost its tender state and attained a firm but not brittle texture.

Cheap Licorice Paste

Wheat flour	70 lb.
Raw sugar	56 „
Glycerine	2 oz.
Molasses	20 lb.
Gelatin	10 „
Caramel (burnt sugar)	14 „
Corn syrup	20 „
Aniseed oil	1 fl. oz.
Raw licorice juice	4 lb.

The gelatin is soaked in cold water until just pliable, several hours before commencing manufacture.

The raw sugar is pre-dissolved in a steam pan and strained through a fine sieve to eliminate any foreign bodies. The broken licorice juice and corn syrup are added, the licorice dissolved, and strained a second time. The batch is placed in a licorice stirring cooker, gelatin and molasses added, and allowed to dissolve. Cooking is commenced, and the wheat flour slowly added, avoiding lumping as much as possible, the caramel is poured in, and the batch cooked until a test piece rolled between the fingers gives a medium ball. The batch is then passed through the licorice refiner to grind all lumps, and transferred to the extruding machine. The rods, ribbons or sheets are taken to a drying room in iron trays and subjected to a constant current of hot air, until the goods are sufficiently dry to either cut on a guillotine, or be used for the production of licorice cream paste goods.

CHEWING GUM

Granulated sugar	15 lb.
Skimmed milk powder	5 „
Gum chicle	20 „
Corn syrup	30 „
Fine icing sugar	30 „
Balsam tolu	1 „
Oil of spearmint	½ fl. oz.

The gum is crushed into small pieces, melted with a gentle heat and strained through a fine stainless steel sieve to remove extraneous matter. The granulated sugar, corn syrup and milk powder are cooked to 250°F. in a stirring kettle. The cooked batch is placed in a heavy duty steel duplex mixing machine, the chicle gum added, then the icing sugar more slowly until the whole is thoroughly mixed to a paste. The spearmint is added and, when well distributed, the batch is transferred to a sugar-dusted slab. The mass is cut into conveniently sized slabs of ½ in. thickness, and passed through a B.C.H. gum rolling, sizing and cutting machine.

If the gum is required for centres to be hard pannep, the batch is cooked to 260°F., so that the centres will keep their shape when revolving in mass.

Balsams, waxes or resins act as lubricators, and eliminate tackiness in chewing gum.

Chewing Gum (Chocolate Flavoured)

4

Granulated sugar	20 lb.
Nulomoline invert	10 „
Corn syrup	35 „
Skimmed milk powder	5 „
Cocoa powder (1 per cent. fat)	15 „
Gum chicle	20 „
Refined beeswax	10 „
Balsam tolu	1 „

The gum chicle is melted and strained, and the beeswax and balsam tolu dissolved by gentle warming. The sugar, corn syrup, invert and milk powder are cooked to 250°F. in a steam stirring pan. The cooked batch is transferred to a duplex mixer and the dissolved gums, wax and balsam are added. The cocoa powder is then added gradually until the whole has been well mixed. The batch is placed on a well-dusted (sugar) cooling slab, and the sizing and cutting process continued as described in the previous formula.

There are many interesting flavours suitable for incorporation in chewing gum, but fruit flavours are not recommended, since they do not associate well with this particular product.

A NEW LINE

Tate's Grade 30 pieces	20	lb.
Corn syrup	30	,,
Date juice (65 per cent. sugars)	12½	,,
Water	1	gal.
Gelatin	1	lb.
Vanillin	½	oz.
Fine desiccated coconut	42	lb.

The gelatin is pre-soaked until pliable, and drained as usual. The sugar, date juice, corn syrup, and water are placed in a steam pan, and when the sugar has completely dissolved, the batch is cooked to 240°F. The cooked batch is transferred to a U-mixer and the soaked gelatin added and allowed to dissolve in the syrup. The machine is set in motion, and the fine coconut added progressively until a full-bodied paste is formed. The vanillin is added, and the batch tinted with liquid orange colour to achieve a rich golden tint in the mass.

The batch is transferred to a sugar-dusted slab, cooled somewhat, and passed through a sizing brake to a thickness of ¾ in. When completely cooled, the sheets are cut to form ¾ in. square pieces on the guillotine. Finally the pieces are moistened with gelatin adhesive solution and thrown in very lightly roasted fine desiccated coconut, so that each piece is adequately coated. The golden-tinted squares should be packed in waxed chutes in suitable containers.

The combination of Tate's Grade 30 sugar, date juice, and fine coconut gives rise to a deliciously flavoured sweetmeat.

CHAPTER XIII

FONDANT

Technique

FONDANT is a balanced mixture of cooked sugar, corn syrup, invert and water, consisting of a mass of minute sugar crystals dispersed in a non-crystallisable liquid medium. This medium is a saturated sugar solution. The size of the sugar crystals obtained in a fondant depends on the amount of inversion of the sugar engendered by the action of the "doctor," such as cream of tartar or invert sugar; the amount of corn syrup used; the length of boiling time, and the temperature to which the batch is cooked. Other factors which govern the ultimate size of crystal are the method of heating and introduction of a colloid, such as egg albumen or gelatin. Cream of tartar hydrolyses part of the sucrose to form invert sugar. Corn syrup retards the rate of crystallisation without chemical change, and also produces a non-crystallisable medium of higher sugar concentration so that the risk of fermentation is minimised. The use of egg albumen or gelatin in a fondant tends to retard the rate of crystallisation by creating a colloidal film around the sugar crystals, so that smaller crystals and a smoother product are obtained.

Invertase

The flowing cream centre is made safely possible by the addition of invertase, a yeast enzyme, to the fondant. Invertase effects a delayed-action inversion of the sucrose, so that a fluid cream is produced some time after the fondant has been chocolate coated—that is, the proportion of non-crystallisable medium is increased. Normally, 2 oz. of invertase to 100 lb. of fondant is sufficient to invert fully a centre in 2 weeks under normal temperatures. The action of invertase, which should be stored in a cool place, is impaired if heated above 140°-145°F. It may safely be added to batches at a temperature of 100°F., and is added when remelting fondant for depositing. As it is a standardised product, no complications can arise in the preparation of fondant cream, providing all other factors are constant.

A deficiency of invert sugar in a fondant will result in a hard dry product, since there is insufficient non-crystallisable medium present to isolate the sugar crystals. Conversely, an excess of invert will result in a non-cohesive mass, which will not set on casting. A fondant should always be cooled to 90°-100°F. before beating, since the higher the temperature of beating, the larger the sugar crystals formed. Furthermore, the water used in fondant making should be soft and neutral to prevent counteraction with an acid doctor.

Formulæ

Fondant Base

Granulated sugar	224 lb.
Corn syrup	56 „
Cream of tartar	½ oz.

The sugar is placed with 8 gal. of water in the steam syruping pan of a fondant machine. It is dissolved thoroughly, so that no isolated crystals of sugar are left adhering to the sides of the pan. The corn syrup is added and brought to simmering point. Any surface scum is taken off. The syrup should test 30° Baumé at boiling point. It is then pumped into the fondant machine and cooked to 240°F. This temperature is variable, according to the degree of stiffness of fondant required. The cooked syrup is cooled to 90°-100°F. and beaten. The resultant fondant base is allowed to mature for at least 48 hours before using. This allows the fondant to become more moist by a redistribution and equalisation of the moisture by diffusion and capillary action.

To produce a short smooth fondant, 28 lb. dextrose hydrate are added to the above fondant batch as it passes into the heating chamber. This may be accomplished by a regulated worm mechanism, so that the dextrose is uniformly distributed throughout the batch. The remelted fondant with its proper proportion of invertase will give a cast cream centre of a soft plastic consistency, which, when eaten, appears cool to the palate, owing to the dextrose hydrate possessing the property of absorbing heat on solution.

Cast Fondant Cream Centres

Fondant base	100 lb.
Invertase	2 fl. oz.
Concentrated fruit juice	8 „

(72 per cent. soluble solids.)

The fondant base is placed in a cream melting pan. It is then heated gently with constant stirring to 130°F., maintained at this temperature, and the invertase, fruit juice, and the desired liquid colour added. The colour should always be filtered before use, so that any undissolved or crystallised specks of colour will not detract from the appearance of the centres. After stirring carefully, the batch is transferred to the depositing machine and cast in starch impressions. The cast centres are allowed to set, cleaned through the Mogul, and coated with chocolate.

Assorted Creams (using Syrup)

Fondant base	56 lb.
White sugar	44 „
Corn syrup	10 „
Essence	¼-¾ fl. oz.
or	
Fruit concentrate	3 „

The sugar and corn syrup are dissolved in 2 gal. of water in a steam pan and cooked to 236°F. This cooked syrup is added to 56 lb. of fondant base in a cream tempering pan, stirred to dissolve the fondant and essence or fruit concentrate, and any liquid colour added, as desired. The batch is deposited into impressions in rubber mats or starch, and the mats or trays set aside until the creams are firm. The cleaned creams are crystallised in 34° Baumé syrup for 12 hours, drained and spread out carefully to dry.

Fourrés

Best granulated sugar	80 lb.
Corn syrup	10 „
Water	2½ gal.
Cream of tartar	½ oz.

The sugar and corn syrup are dissolved in the water in the syruping pan of the creaming plant. Cream of tartar dissolved in a little water is added. The creaming plant is set in operation, the syrup cooked to 236°F., creamed, and allowed to mature for at least 48 hours, with a wet cloth over the batch. Convenient amounts are transferred to a water-jacketed melting pan whose temperature can be thermostatically controlled at 172°F. This melted cream, which has been delicately coloured and flavoured, is apportioned to water-jacketed dipping pots. The operator throws the centre in the cream and extracts it by means of a fork, and places the dipped centre on a clean metal plaque, forming a surface decoration with the finger. The fourrés are stacked in a cool place to set. They are finally crystallised in 34° Baumé syrup for 12 hours. When finally drained, the fourrés should be spread out to dry in wire trays, so that the crystallised surfaces will not be marked.

Almost any type of confectionery may be dipped in fondant, for example, brazil nuts in coffee-flavoured and coloured fondant.

CHAPTER XIV

PASTILLES, GUMS AND JELLIES

Function of the Colloids

The range of pastilles, gums and jellies is of almost infinite variety, and these sweets in their many interesting forms enjoy universal popularity.

The characteristic texture of these products is achieved by the use of gelatin, agar-agar or isinglass, gum arabic, citrus pectin, and specially treated corn starch. The pectin, isinglass and weak proportion of gelatin provide the softer jellies, strong proportions of gelatin produce a tougher pastille, and the gum-arabic a hard, brittle sweet.

Precautions.—The successful production of soft jellies requires a careful attention to balance of constituent ingredients and the actual processing to eliminate any tendency to grain or sweat, a common failing. Formulæ must be strictly adhered to, materials accurately weighed, placed in the cooker in the proper order, and cooked to the exact degree of temperature required. In the case of pectin jellies, all of the required amount of moisture must be evaporated during the actual cooking process, as pectin is a moisture binder, and pectin jellies do not give up their moisture easily. This means they have a longer shelf life and do not require to be placed in a drying room after they have been cast in starch or porcelain moulds. Pectins will not gel in the absence of an acid such as tartaric or citric; a direct relationship exists between the amount of pectin and acid used and the sugar concentration of the final product.

Agar-agar is always soaked overnight in an ample volume of cold water. Adequate absorption of water is necessary, since under-soaked agar is insoluble even in hot sugar solution. Here again, extra care must be exercised, and the exact amount of acid added to the batch, particularly if allowance has to be made for the inclusion of fruit pulps which already contain fruit acids. Over-acidulation leads to sweating, under-acidulation results in a short brittle jelly. As prolonged subjection to heat destroys the gelling power of agar, the batch is poured into a water-cooled vessel preparatory to depositing. Excessive stirring in any form of gum, pastille or jelly is to be discouraged, since granulation readily occurs on agitation. To produce clean work and to prevent unsightly incrustation, the moulding starch used should not contain more than 4 per cent. moisture. The moisture content of the starch can be checked quite easily, and any excess moisture and tailings removed by passing the starch through drying and dressing machines.

Continental confectioners, particularly in Austria, have for many years preferred to deposit their agar jellies in porcelain moulds, from which they were certain to obtain uniformly perfect impression. The processes of freeing from starch and steaming are eliminated, and the moulds easily prepared for further filling.

Testing.—The scientific method of testing the end point of pectin jelly batches is by means of a direct reading refractometer, which gives the percentage of soluble solids in the batch.

Formulæ

Hard Gums

Gum arabic	42 lb.
Granulated sugar	28 „
Corn syrup	7 „
Glycerine	2 pints.
Acid	4 oz.

Colour and flavour as required.

The gum is dissolved in 2 gal. of water and passed through a hair sieve. The sugar and corn syrup are cooked to 250°F., the gum solution and glycerine added, and the scum taken off with a perforated ladle. The solution is stirred gently, and acid, flavour and colour added. The batch is deposited in starch impressions and the trays placed in the drying rooms at a thermostatically controlled temperature of 120°F. for 7-10 days, until the required texture is obtained. The gums are then passed through the Mogul, and cleaned by steaming machine, laid out on wire trays to dry bright or crystallised, as the case may be. The inclusion of glycerine in the batch prevents the gums drying to stone hardness, by virtue of its moisture-retaining property.

Hard Gums (Alternative Method)

Gum arabic	40 lb.
Granulated sugar	28 „
Corn syrup	7 „
Citric acid	4 oz.

Flavour as desired.

The gum is placed in 2 gal. of water in a steam kettle and dissolved thoroughly. The gum solution is filtered through a hair sieve. The sugar and corn syrup with 1½ gal. of water, in which the acid and flavour has been well stirred, are placed in a steam pan and stirred until the sugar is dissolved. The batch is allowed to simmer unstirred until it rises. The steam is turned off, and the batch allowed to settle and impurities skimmed from surface. The batch is reheated until it rises a second time, and the settling and skimming process repeated. The batch is passed through a hair sieve and left in a warm pan for 4 hours to settle and clarify. Finally, it is skimmed and deposited in starch. It is allowed to stove for 2 days at 120°F. These gums are softer than those of the previous formula, and are suitable for crystallising.

Lemon Squash Gums

Granulated sugar	145 lb.
Corn syrup	170 „
Gelatin	60 „
Citric acid	2 „
Lemon oil	24 fl. oz.
Lime oil	4 „
Amyl acetate	2 „

The gelatin is soaked in cold water until pliable. When the gelatin is drained and ready for use, the sugar and corn syrup are placed in a steam pan with sufficient water to cover the solids. The steam is turned on, the sugar thoroughly dissolved by stirring, and the surface is skimmed. Stirring is discontinued and the batch cooked to 250°F. The cooked batch is allowed to cool for a few minutes, the gelatin added, stirring gently until completely dissolved. The batch is poured into a receiving pan, giving it time to clarify. The skimming of the surface is repeated. The citric acid, dissolved in the least possible amount of water, and flavours are added, and the batch coloured as required. The colour should be added always in filtered solution form.

The batch is deposited into clean, warm and dry starch, and stoved for 7-10 days at 120°F., according to the degree of hardness required. The gums should not be taken from the stoves before they become somewhat brittle when cooled and tested, otherwise, on exposure to the ordinary humidity of the air, they will settle into a mass when packaged. When stoved sufficiently, the gums are passed through the Mogul, and then through a dry steam chamber for cleaning. Finally, the cleaned gums are placed in a revolving drum with a little high-grade petroleum jelly to prevent sticking.

By substituting the following flavours for those in the previous formula, and omitting the citric acid, Linseed, Licorice and Chlorodyne Gums may be produced:

Chloroform	10 fl. oz.
Capsicene	⅛ „
Oil of aniseed	1 „
Linseed oil	2 „
Licorice juice	10 lb.
Black colour powder	4 oz.

Blackcurrant Pastilles (with concentrated fruit juice)

Granulated sugar	60 lb.
Gelatin	14 „
Corn syrup	60 „
Citric acid	1¼ „
Concentrated blackcurrant juice ..	12 „
Blackcurrant essence	1½ fl. oz.
Liquid black colour as required.	

The gelatin is pre-soaked until pliable. The sugar and corn syrup in sufficient water are cooked to 245°F. Gelatin, blackcurrant juice, citric acid dissolved in a little warm water, finally colour and essence are added. The batch is cast in warm dry starch and stoved for 4-5 days at 120°F., then crystallised in 34° Baumé syrup. Alternatively, it is passed through the dry crystallising machine.

Tangerine Jellies (Agar Fruit)

Granulated sugar	86 lb.
Corn syrup	40 „
Sieved apple pulp	16 „
Sieved apricot pulp	16 „
Agar	2 lb. 2 oz.
Citric acid	4 oz.
Tangerine essence	8 fl. oz.
Sweet orange essence	1 „

The agar is soaked overnight in cold water. It is then drained and placed in a steam pan with 56 lb. sugar and 40 lb. corn syrup. The sugar and agar are completely dissolved, then cooked until the batch hangs in long threads from the testing spatula. Simultaneously, in another pan, the apple and apricot pulp and 30 lb. sugar are cooked to 226°F. The essences and acid are carefully stirred in, and the two batches mixed thoroughly but without undue agitation. The combined batch is allowed to cool to 140°F., deposited in warm dry starch, and stacked in a warm room to allow the jellies to set. When quite firm, they are passed through the brushing machine to free from starch, then through the steam chamber and sugaring machine for dry crystallising. The jellies must be protected from bruising in these operations, otherwise the appearance is impaired.

Using this formula as a basis, assorted fruit flavours and colours may be substituted to give an attractive range of fruits, which look well, packed in crimped glassine cups, either in drums or cartons. The moulds take the approximate form of the natural fruits they represent.

Ginger Jellies: *First Batch*

Crushed cargo ginger	60 lb.
Apple pulp	28 „
Granulated sugar	35 „
Raw sugar	35 „

Second Batch

Agar	5¼ „
Granulated sugar	110 „
Corn syrup	70 „
Ginger essence	1 fl. oz.

The agar is previously soaked in water overnight.

In one steam pan, the cargo ginger, white and raw sugar, and apple pulp are cooked, after dissolving the sugar completely, to 226°F.

Simultaneously, the second batch is cooked in a separate pan to a good thread on the testing spatula, and the two batches mixed thoroughly. The combined batch is deposited in warm dry starch in moulds shaped to represent ginger root, and the trays placed in a warm dry room and the goods allowed to set thoroughly. They are then cleaned and dry crystallised, as for the previous formula. Packed in card or ply drums, these produce a very attractive line.

Citrus Pectin Jellies

Best white sugar	50 lb.
Citrus pectin (100 grade)	3½ „
43° Baumé corn syrup	50 „
Water	50 „
Citric acid	3 oz.

The pectin is first mixed with 5 lb. sugar in a dry container. This assists even distribution throughout the batch. The given volume of water is measured into a steam pan. The pectin-sugar mixture is added slowly and brought to the boil, stirring continuously. The corn syrup is added slowly whilst boiling, then the remaining 45 lb. sugar gradually, stirring to dissolve sugar completely. The batch is cooked to 232°F. (or 20°F.

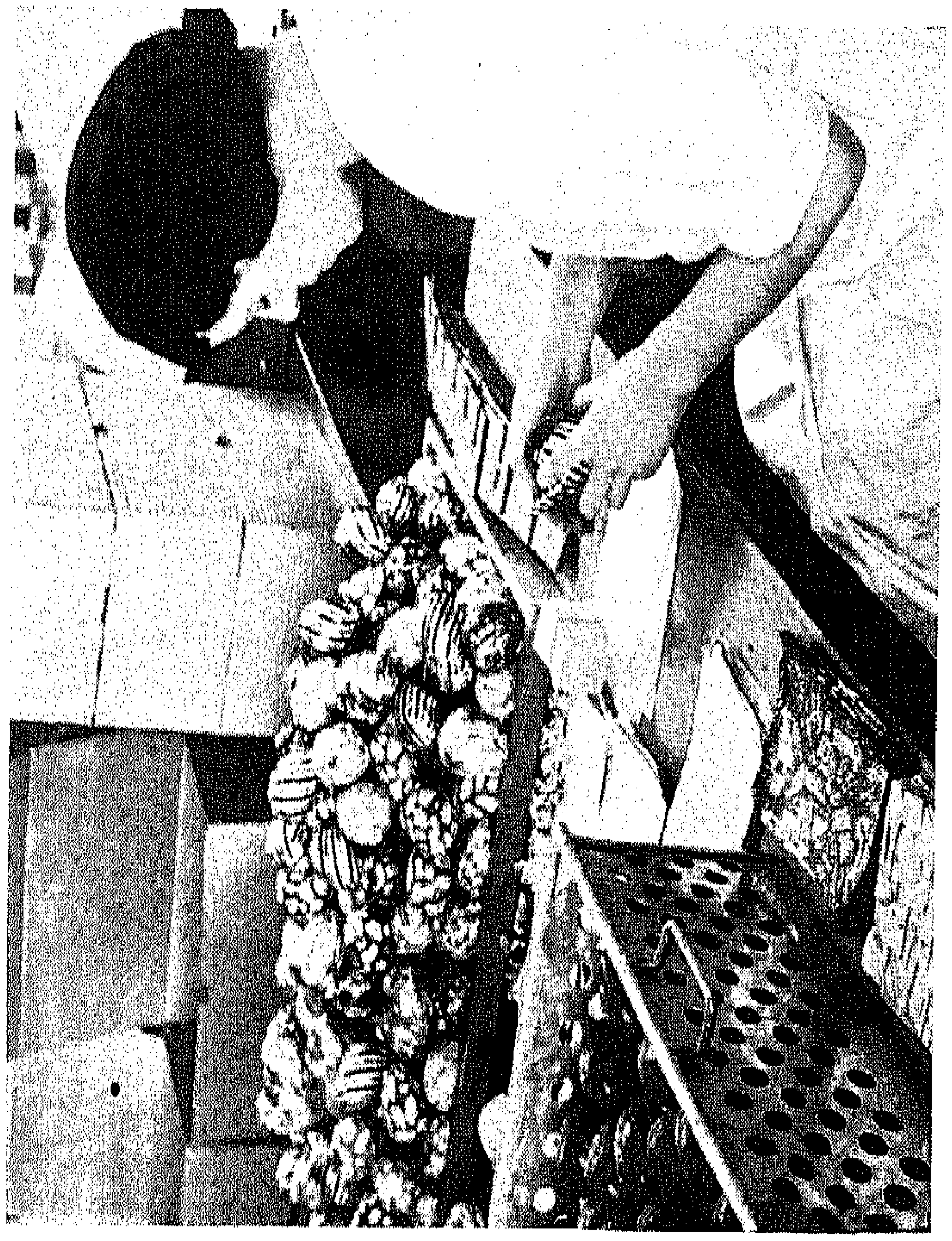


Fig. 62.—Hand Foiling Easter Eggs.

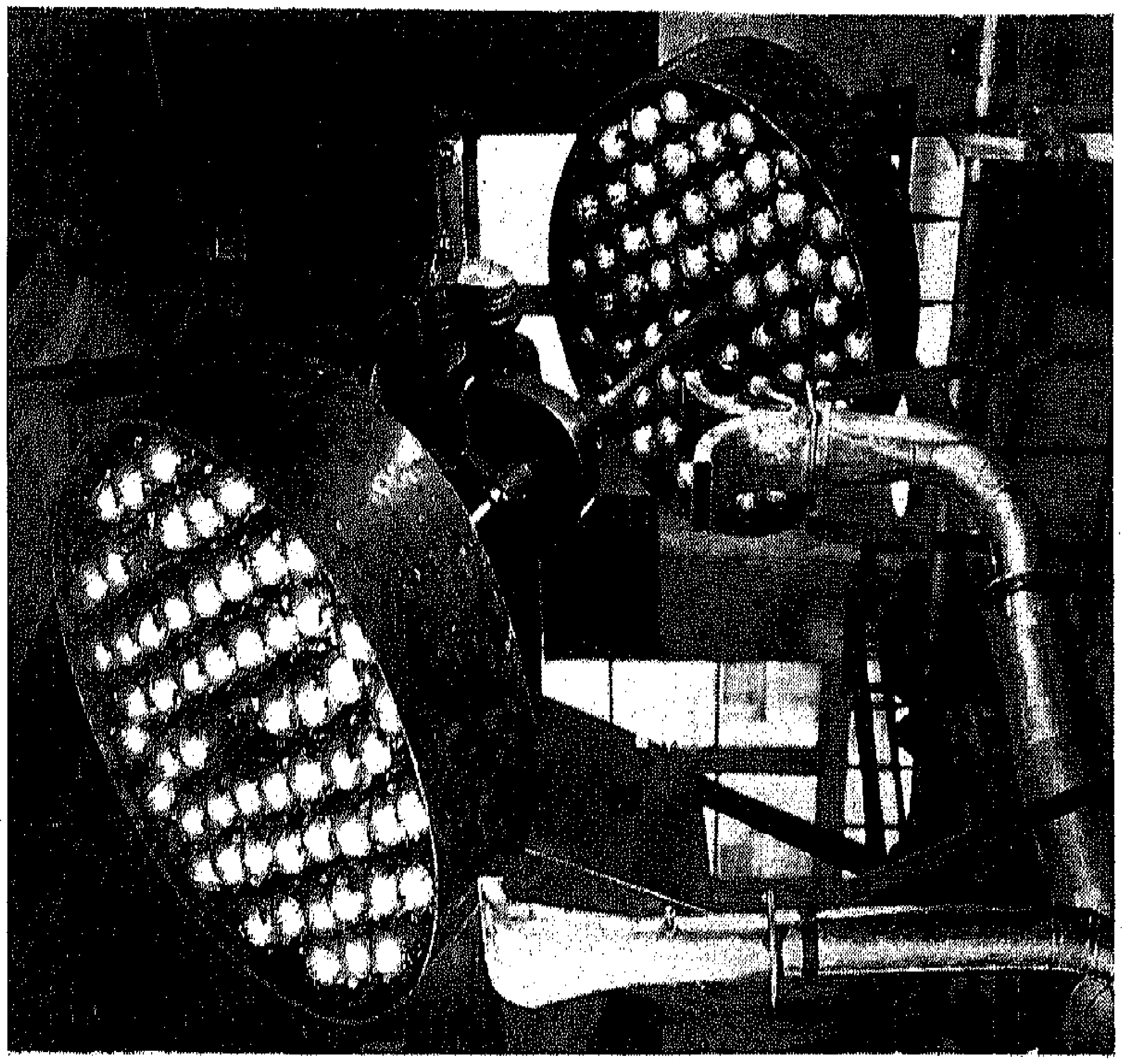


Fig. 61.—Egg-Mould Spinning Machine.

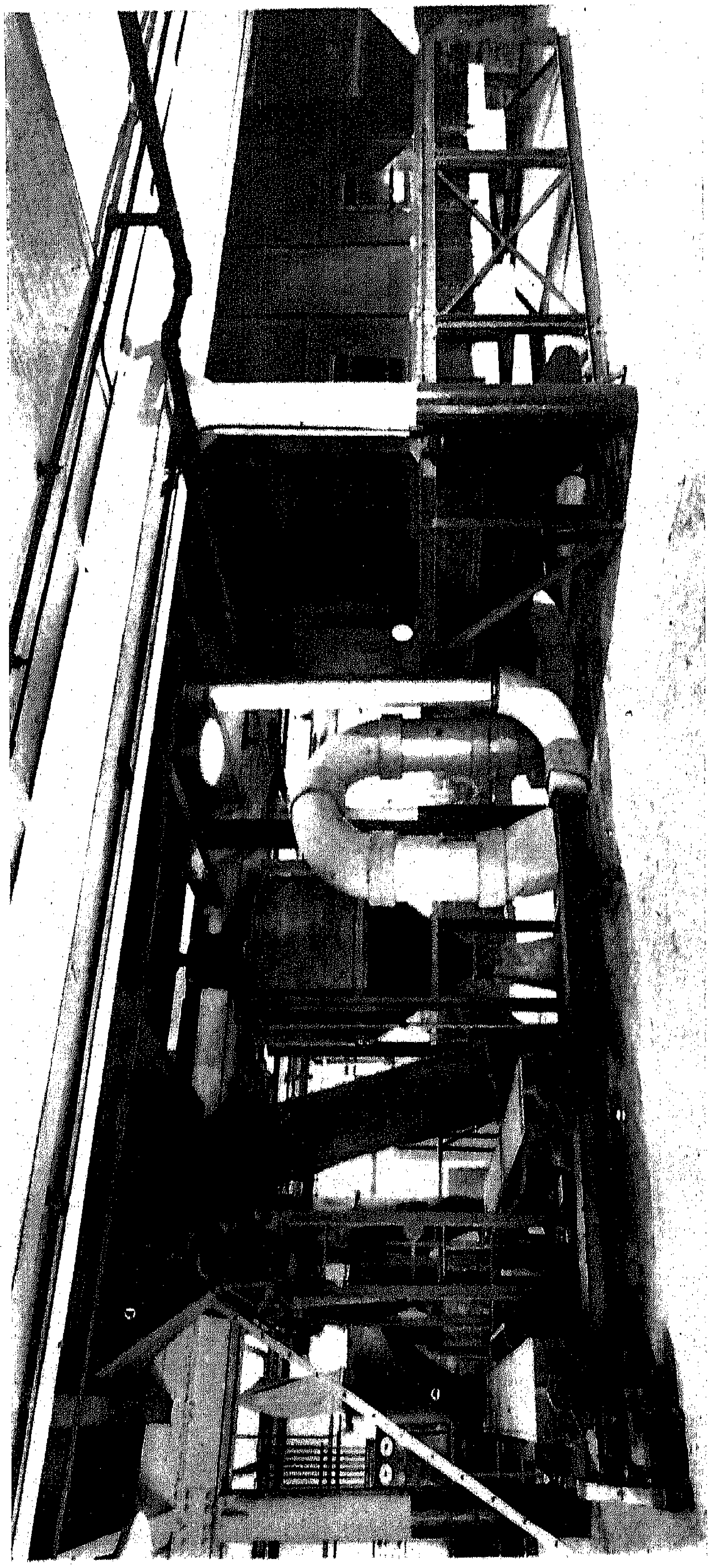


Fig. 63.—British "Rema" Automatic Cocoa Powder Plant.

above prevailing boiling point of water) to secure a refractometer reading of 82·5 per cent. soluble solids in the batch, of which the final yield should be 111 lb. When somewhat cooler, the acid, dissolved in ½ pint of water, is added, and the batch flavoured and coloured and mixed carefully without touching the sides of the pan. It is deposited in starch impressions and set aside in a warm dry place until the jellies have firmly set. The jellies are passed through the brushing machine, steaming chamber, and dry crystallised.

To ensure uniformity of product, flavouring and colouring should be strictly standardised, as there is very little margin between success and failure in the production of pectin jellies. For variations of the above standard formula, add fruit pulp, ground fruit or nuts.

Rejected agar or pectin jellies or pieces may be chopped and used as a filling in fruit nougat, fudge or coconut paste work.

Acidulated Jellies (Lime)

Granulated sugar	28 lb.
Corn syrup	7½ „
Gelatin	3 „
Citric acid	4 oz.
Oil of limes	½ fl. oz.

The gelatin is pre-soaked in cold water until just pliable.

The sugar and corn syrup are placed in 1 gal. of water in a steam pan and boiled and stirred to dissolve the sugar completely. If undissolved sugar crystals are allowed to remain on the side of the pan, granulation will take place in the final product. The batch is cooked to 236°F. The steam is turned off, the citric acid dissolved in a minimum of warm water, and the flavour and required liquid colouring are added with as little agitation as possible, taking care not to scrape the sides of the pan. The batch is transferred to a depositor and deposited in fruit-shaped moulds in warm dry starch. The starch is sifted over the tops of the jellies, and the trays stacked in a warm dry place to allow jellies to set. The sifting of starch over the surface assists case-hardening of the weak jellies, which prevents drying out. The jellies are freed of starch in the Mogul, subjected to air blast and crystallised by the usual method in 34° Baumé syrup for 6 hours.

All-Starch Gums

Corn syrup	80 lb.
Water	6 gal.
Fruit essence	1½ fl. oz.
Thin boiling starch (fluidity 40-45) ..	8 lb.
Citric acid	3 oz.

The corn syrup is placed in 3 gal. of water in a steam stirring pan and boiled. The starch is whisked in 3 gal. of water to a thin paste and added slowly to the corn syrup, allowing progressive gelatinisation to take place, as in the process for Turkish Delight. Cooking is continued until the batch thickens, and the citric acid, dissolved in a little hot water, added. Testing is carried out by dipping a wooden spatula in the batch and allowing to drip over the pan. When the stringy sheet springs back to the spatula, the batch is cooked sufficiently. The flavour and colour are added, and the liquid transferred to a depositor and cast in impressions in warm dry starch.

The goods are stoved for 5-7 days at 110°-120°F. They should be hard and brittle when a test piece is cooled. The gums are passed through the Mogul for cleaning, then through the steaming and sugaring machine. The goods should be dried well before packing.

Jelly Beans (Starch)

Corn syrup	28 lb.
Thin boiling starch (fluidity 60).. ..	2½ ,,
Water	4 gal.
Citric acid	1 oz.
Fruit essence	½ fl. oz.

The process is exactly as described for all-starch gums. The final cooked point is reached when a good sheet is obtained on a spatula, which has been dipped in the batch and held over the pan horizontally.

The goods are deposited in jelly bean moulds and stoved for

5 days at 110°-120°F., then cleaned and transferred to the Dragée department for soft sugar coating in revolving pans. These goods must be very brittle and should not be allowed to remain for any length of time before coating, otherwise softening will occur.

Dessert Figs

First Batch.		*Second Batch.*	
White sugar ..	56 lb.	White sugar ..	7 lb.
Corn syrup ..	14 ,,	Raw sugar ..	7 ,,
Agar-agar ..	2 ,,	Apple pulp ..	7 ,,
		Fig pulp ..	25 ,,

The agar is soaked in an ample volume of cold water overnight.

Before commencing manufacture, about 112 lb. or more of dried figs is placed in a steam pan, the amount depending upon the number and capacity of the steam pans available. The figs are covered with water and boiled until quite soft and pulpy. 112 lb. of dried figs should yield 168 lb. fig pulp, therefore the water used is regulated to achieve this bulk. The boiled figs are passed through a fruit pulping machine to obtain a uniform pulp free from stalks, straw and other foreign matter. The fig pulp is then available for use in the process as required.

56 lb. of sugar and 14 lb. of corn syrup, with water to cover, are placed in a steam pan, the steam turned on, and the batch stirred to dissolve the sugar thoroughly. The strained agar is added, stirred to dissolve, and the batch cooked to a good sheet on the spatula. It is allowed to cool somewhat, and skimmed of any surplus scum.

In another steam pan, the 7 lb. white sugar, 7 lb. raw sugar, 25 lb. fig pulp, and 7 lb. apple pulp are placed and cooked to 226°F.—*i.e.*, to a stiff jam.

The second batch is added to the first and mixed thoroughly without unnecessary agitation. The combined batch is transferred into the depositor of the Mogul and deposited in impressions, appropriately shaped, in dry warm starch. Starch is sifted over tops of trays to assist case-hardening. The filled trays are stacked in a warm, dry room until set. When thoroughly set, the goods are passed through the Mogul machine, dry steamed lightly, rolled in caster sugar and set out in trays to dry.

These dessert figs can be very attractively packed in card or ply drums and cartons. A small metal or plastic fork and a decorative imitation leaf are usually placed on top of the packed figs for effect.

It is important to ensure that the second batch is a stiff jam, otherwise the final product will incline to weep, owing to the presence of excess moisture.

Turkish Delight

Granulated sugar	37½	lb.
Corn syrup	21	„
Citric acid	6	drams.
Thin boiling starch (fluidity 65)	9	lb.
Honey	4	„
Soluble oil of lemon	¼	fl. oz.

The sugar and corn syrup are placed in a steam stirring pan with 3 gal. of water. The batch is boiled to dissolve the sugar. The thin boiling starch is mixed to a thin paste in 1½ gal. of cold water and added to the batch slowly. The latter is cooked at 60 lb. per square inch steam pressure, until the batch does not adhere to the hand when struck. The steam is turned off and the honey and lemon essence added. When well mixed, the batch is poured out into heavily starch-dusted trays, and corn starch sprinkled over the surface of the material. The trays are stacked in a dry place to cool. When cool, the sheets are cut on a guillotine or by hand knife, and the pieces copiously dusted with finely ground sugar.

Turkish Delight is always packed with a generous helping of finely ground sugar, which prevents sticking and assists a certain amount of case-hardening of the pieces. An alternative dusting powder consists of 75 per cent. ground sugar and 25 per cent. corn starch.

This sweetmeat is usually made in two-colour layers. One batch, flavoured lemon, is run into the dusted trays to a pre-

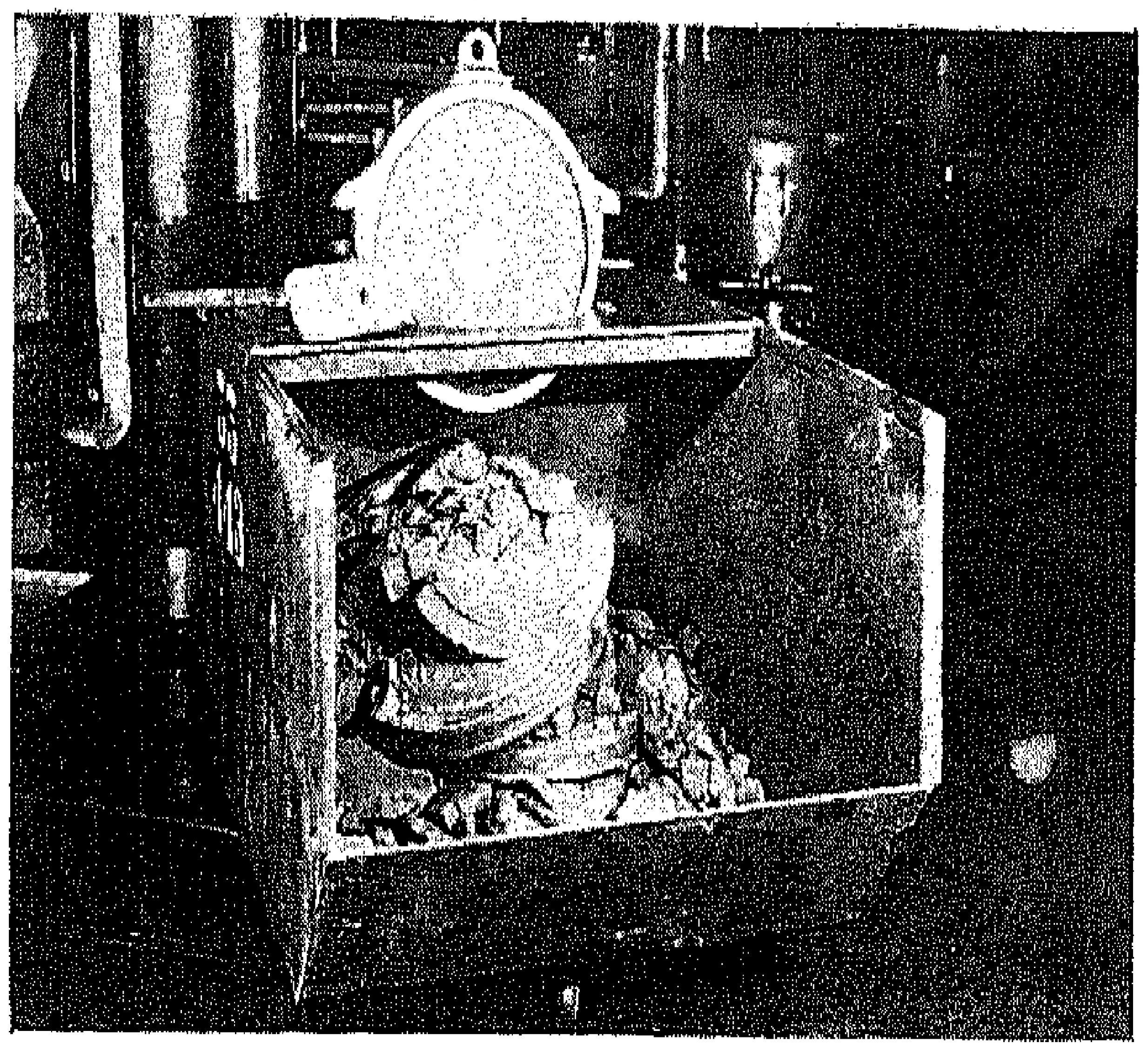


FIG. 64.—EXTRACTING COCOA CAKE FROM PRESS POTS.

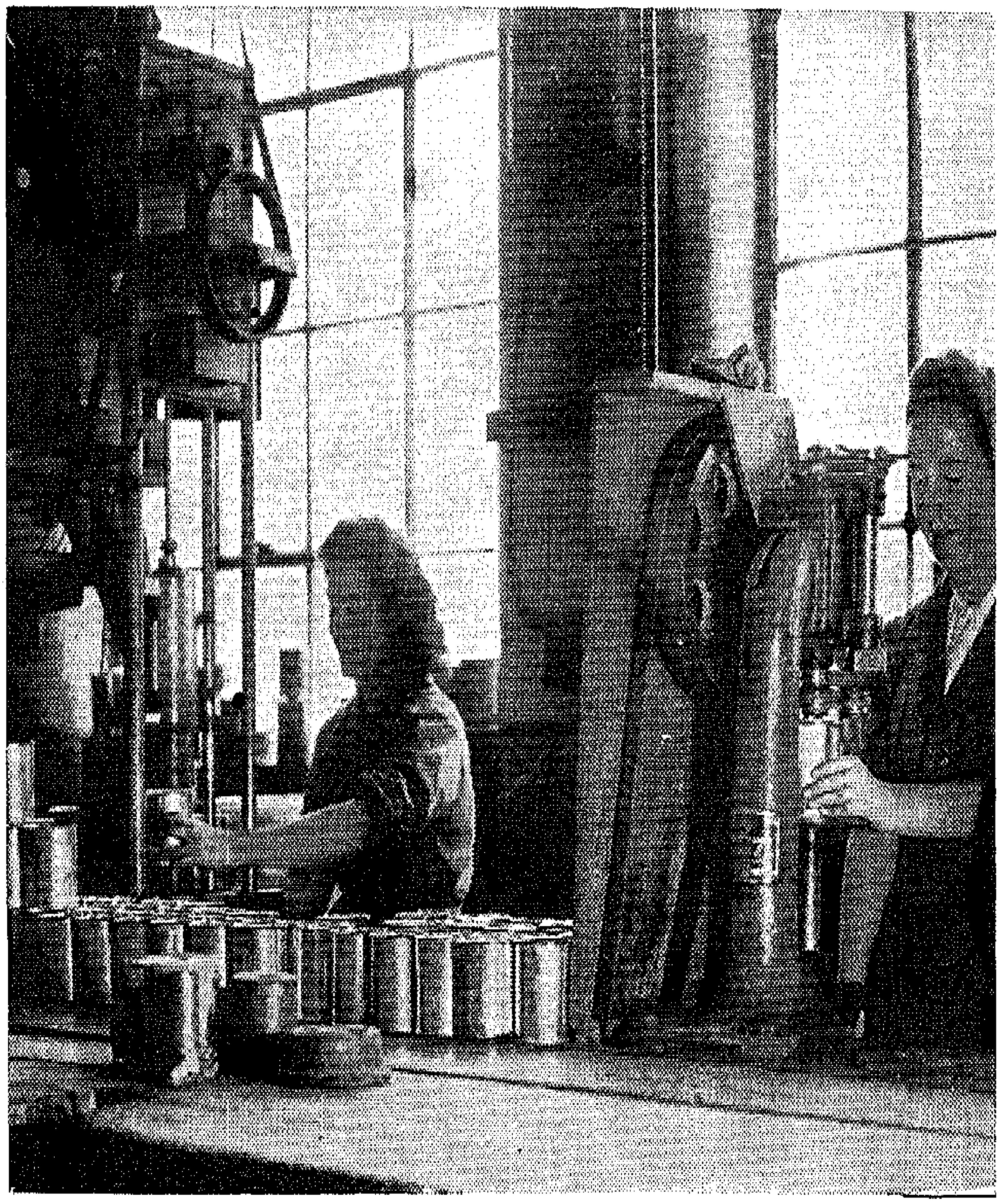


FIG. 65.—POWDER FILLERS.

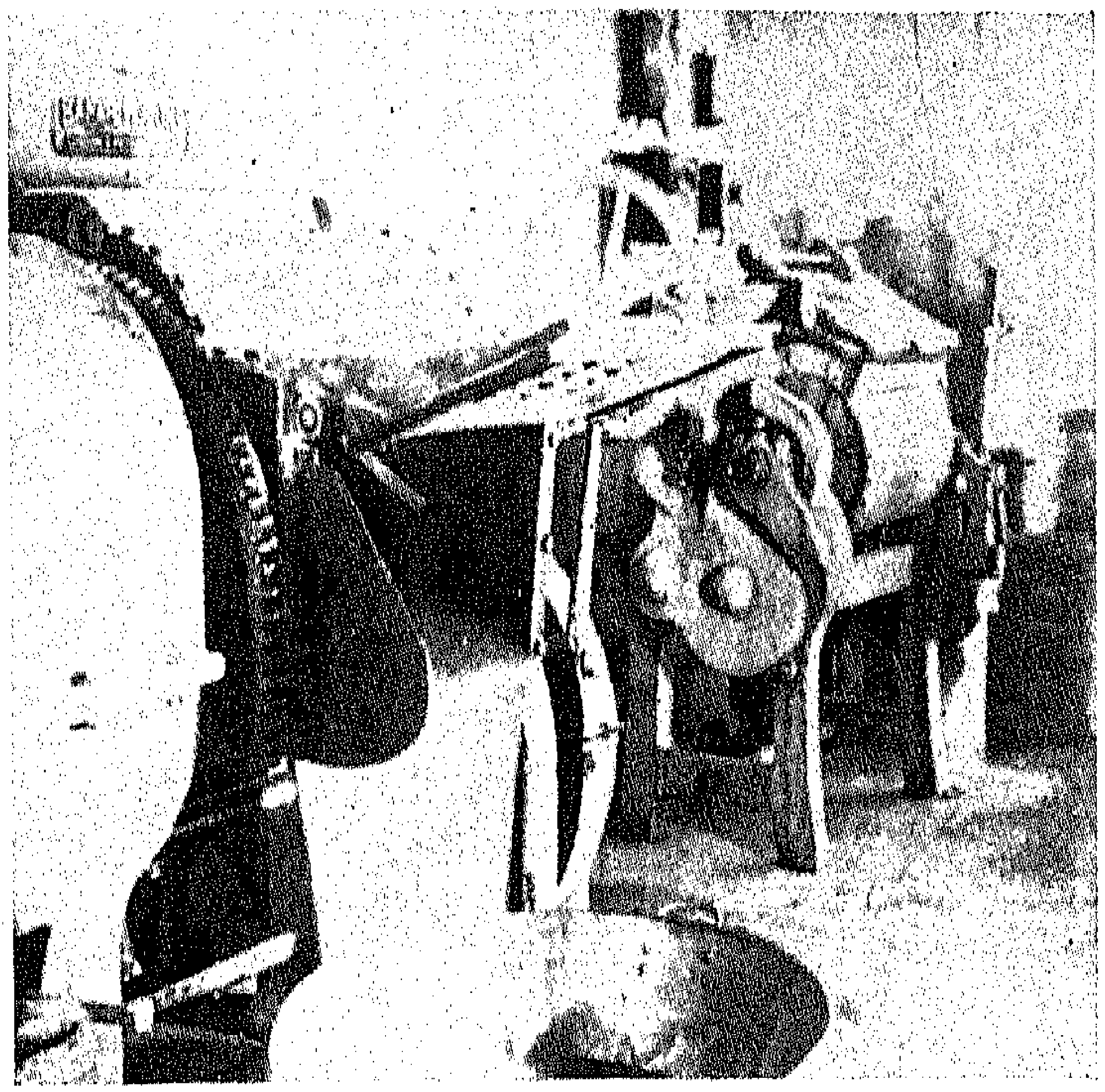


FIG. 66.—PASTE MIXERS.

FIG. 67.—CONFECTIONERY PACKING DEPARTMENT.

determined thickness, and a second batch coloured pink, flavoured with diluted attar of rose, run on top of the first.

The suspended starch solution must be added slowly, so that complete gelatinisation of the starch takes place progressively. An efficient stirring cooker is an essential in order to obtain a uniform heating throughout the mass during the cooking process.

Gelatin Lozenges

Gelatin	24 lb.
Granulated sugar	24 „
Citric acid	1 lb. 14 oz.
Oil of lemon	1½ fl. oz.

The gelatin is pre-soaked in cold water until it is just pliable, then drained. The soaked gelatin is melted in a steam pan and the sugar added. Cooking is continued whilst stirring to dissolve the sugar, and until the batch becomes firm enough to produce an immediate strong set when a test drop comes into contact with a cold plate. The citric acid, previously dissolved in a pint of hot water, and the oil of lemon are added and stirred gently, and the liquid poured on well-oiled iron trays to a ⅛ in. thickness. It is allowed to cool, and cut with a round lozenge cutter. The cut lozenges are put aside to dry out well so that they show no tendency to stick, then packed in tightly sealed tins.

Liqueurs

Granulated sugar	16 lb.
Gum arabic mucilage	4 fl. oz.
Water	5 pints.
Liqueur essence	½ fl. oz.

8 lb. of sugar is dissolved in 2½ pints of water to form a crystal-free syrup, which is then cooled, ensuring there is no disturbance. A little water is sprinkled over the surface to prevent a crust forming.

8 lb. of sugar in 2½ pints of water is cooked to 246°F. The first syrup is poured into this and stirred very carefully. The

gum mucilage and flavour are added, and the solution cast in impressions in warm, dry starch. Dry starch is sifted over the surface to assist crust formation, and the trays placed in a cool place for 8-12 hours. The liqueurs are turned over with a long wire mesh scoop and allowed to stand a further 8-12 hours to form a uniform crust. They are cleaned by sieving and air brushing, laid out in crystallising tins, and crystallised in cold syrup at 34° Baumé for 12 hours. The liqueurs are then drained and placed on wire trays to dry, and finally coated with chocolate or placed as a centre in chocolate moulds of appropriate design, or used as a centre for pectin or agar jellies. To obtain a clear mucilage, gum arabic should be dissolved in its own weight of cold water. Where transparency is not essential, solution may be accelerated by the application of a little heat.

Liqueur Coffee Berries (Dragée Finish)

The previous formula may be used, substituting ½ fl. oz. of coffee essence for the liqueur flavour, and processing as described. The drained, but still damp, goods are placed in a dragée pan and dusted immediately with finely powdered gum arabic. This will result in a coat of gum covering each piece to prevent its breaking. Finally, the coating process is continued as described for chocolate dragées in Chapter XI.

Piping Jelly

Sugar	10 lb.
Corn syrup	7½ „
Water	1¼ gal.
Agar-agar	6 oz.
Citric acid	½ „
Fruit essence	¼ fl. oz.

The agar-agar is soaked in 1¼ gal. of water until fully absorbed, then finally dissolved by application of a little heat. The sugar and corn syrup are added and cooked carefully to 214°F. The batch is withdrawn from heat, and citric acid dissolved to a solution in water, and essence and colour added. The surface of the batch is skimmed free from impurities and poured into glass containers.

The following dark pastille formula will be found efficacious in utilising the "waste" products of many confectionery departments. The "waste" referred to in the formula is composed of rejected jellies, pastilles or gums, hard sugar goods, rock ends, marshmallow, nougat and fondants. In short, any confectionery combination capable of being readily redissolved in water.

Dark Licorice Pastilles

Waste	112 lb.
Licorice juice	3 „
Gelatin	14 „
Oil of aniseed	1 fl. oz.
Black colour	2-4 oz.

The gelatin is pre-soaked until pliable. The waste is placed in a tilting steam pan in sufficient water to cover adequately and to allow for loss through evaporation. It is heated to boiling point, allowed to simmer, and stirred well until all the waste is dissolved. The steam is turned off, the batch allowed to settle, and the surface skimmed carefully until quite clear. The gelatin and licorice juice dissolved in hot water, black colour solution and oil of aniseed are all added, and the batch stirred until the gelatin has dissolved. The batch is again allowed to settle, the surface skimmed, and the batch deposited in pastille-shaped impressions in warm, dry starch. The goods are stoved overnight and put through the Mogul to clean off starch, then through the B.C.H. crystallising machine.

The black colour is dissolved in hot water and filtered before adding to the batch.

CHAPTER XV

MARZIPAN

Two methods may be used for the manufacture of marzipan; one is a German method which embodies the cooking of ground almonds and sugar, with or without the addition of inverts; the other is the method more generally used of pre-cooking a sugar-corn syrup solution and mixing with ground almonds and fondant. The former is obviously more expensive, though the resultant marzipan is a highly palatable confection. Whichever method is employed, the addition of a proportion of about 5 per cent. bitter almonds will improve the ultimate flavour.

French manufacturers thoroughly dry the almonds after blanching, which process is claimed to result in a more sharply pronounced almond flavour.

Formulæ

Marzipan (German Method)

Almonds	60 lb.
Granulated sugar	40 „
Corn syrup	2 „

First, all impurities and foreign bodies are eliminated from the raw almonds, which are dipped in boiling water to loosen skins and blanched in the blanching machine. They are passed through a grinding machine, then through a triple-roll refiner. The resultant almond mass is mixed with the granulated sugar and corn syrup, and transferred to the marzipan cooker and cooked until the batch is sufficiently dry to be kneaded in the wet fingers without sticking. This test should be augmented by a weighing test of the cooked batch, so that a correct standard of evaporation of moisture is determined, and each subsequent batch should conform to that standard. Only in this way will uniformity be achieved. The paste is then

cooled and stored until required for moulding into bars or cutting into pieces. Before these manipulative operations are undertaken, the cold paste is re-run through the refiner. The moulded marzipan is allowed to case-harden in a dry warm room, then crystallised in cold syrup at 34° Baumé for 8 hours to prevent further drying out.

Marzipan

Granulated sugar	60	lb.
Corn syrup	14	„
Ground almonds	30	„
Fondant	14	„
Glycerine	4	fl. oz.
Almond oil	¼	„

The almonds are sorted, blanched and refined, and placed in a U-shaped mixing machine. The sugar and corn syrup are cooked in a steam pan to 250°F. The cooked batch is poured on the ground almonds, and the fondant and glycerine added. After allowing to mix thoroughly, the batch is cooled and passed through the refiner. The marzipan may be rolled into sheets of any desired thickness and cut into bars which are crystallised. Alternatively, the paste may be worked into mosaic patterns and drawn out after the fashion of boiled sugar batches into variously-shaped rods, which are cut up into pieces on a guillotine, then crystallised in syrup at 34° Baumé for 6 hours.

Marzipan Fruits and Mosaics

For decorative work the paste may be formed into fruit shapes and painted with edible colours to heighten the effect, which is enhanced by the use of imitation stalks and leaves. The fruits may be crystallised in the ordinary way, or glazed with a solution of gum-benzoin in alcohol. Interesting designs in marzipan can be easily formed for the purpose of making hollow goods such as Easter eggs.

The creation of a mosaic pattern in marzipan is quite a simple operation, provided care is exercised to prevent distortion and crumbling. This work is carried out as follows:

Portions of the paste are delicately coloured, and each portion formed into a rectangular block about 4 in. square and 18 in. long, each portion being lightly brushed with gelatin-adhesive and fitted together in the required pattern. A sheet of non-coloured paste is rolled out to a thickness of ½ in., brushed lightly with adhesive solution, and wrapped completely around the block. The shape of the complete block is maintained by pressing lightly between boards, and whilst an assistant attends to the large end of the block, the other end is drawn out, using the palms of the hands, gradually and progressively diminishing the size, until a square ribbon of the required dimensions is obtained. Lengths of 18 in. are cut off, and each length packed in a sugar-dusted tray. The drawing out is continued until the whole block has been used. The goods are placed in a warm, dry room to case-harden. Finally, the bars are cut into pieces of the required size and crystallised in cold syrup at 34° Baumé for 6 hours.

More ambitious designs may be worked out and planned on paper, then produced in marzipan paste on similar lines to mosaics.

A pseudo-almond paste may be produced by the substitution of peach or apricot kernels for almonds, oil of almonds being added to provide the characteristic flavour. It must, however, be borne in mind that a name for first-class confectionery cannot be built up on substitutes.

Praline

Praline, based on the combination of finely ground nuts, boiled sugar and varied flavouring, makes an ever-popular chocolate centre, or truffle. No chocolate assortment is complete without the inclusion of a praline in some form or other.

The confection known as truffle usually has a praline centre, which is dipped in chocolate and rolled in cocoa or chocolate powder, or chocolate vermicelli, whilst the chocolate is still plastic. High-class truffles contain spirits and liqueurs, which blend admirably with the basic ingredients to form a delightful confection.

Praline Base

White sugar	56 lb.
Blanched almonds	28 „
Blanched hazelnuts	28 „

The almonds and hazelnuts are roasted at 295°F. The sugar, with sufficient water, is placed in a small steam pan or gas-heated pan, heated and stirred until the sugar is completely dissolved. The roasted nuts are added and cooked to 315°F. The cooked nuts are poured on a water-cooled slab, and when cold, broken up, placed in a melangeur to pulverise, and passed through the refiner.

Using this paste as a base, any suitable flavouring and other ingredients, such as ground dry fruits, cacao liquor, chopped nuts, etc., may be added to provide an interesting range of candies.

Milano Chocolate Paste

Hazelnuts	40 lb.
White sugar	40 „
Cacao liquor	14 „
Cacao butter	6 „
Vanillin	1 oz.

The nuts are roasted at 295°F. The sugar is dissolved in water in a cooking pan, cooked to 315°F., and the nuts added. The batch is poured on a water-cooled slab, and when quite brittle, pulverised in the melangeur. The cacao liquor and cacao butter are added, thoroughly mixed and refined twice. The mass is transferred to a conche for 7 hours, adding vanillin towards the end of the operation. The mass may then be poured into clean metal trays for subsequent cutting into pieces for chocolate centres, or formed whilst in a semi-solid state into balls for the production of truffles. Milano chocolate paste also provides a pleasing spread for biscuit sandwiches, or an intermediate layer with other confectionery such as albumen nougat in bar goods.

Noisettes

Hazelnuts	68 lb.
White sugar	40 „
Cacao liquor	52 „
Vanillin	1½ oz.

The method of processing is exactly as described for Milano paste, omitting the conching, since this base is intended solely for the production of truffles, and the double refining should provide a sufficient degree of fineness. The refined mass is placed in containers in a hot stove and stoved at 140°F., until the material is needed for actual production.

28 lb. of the paste is placed in a warm mixer, 5 lb. of fondant base added, and when the above is thoroughly mixed, an addition is made of 3 fl. oz. alcohol, to which has been added ¼ fl. oz. Curaçao and ¼ fl. oz. Maraschino. The batch is allowed to mix well and is transferred to a dusted marble slab and formed into balls about ½ in. diameter. These are dipped in melted plain chocolate at a temperature of 88°-90°F. and rolled into chopped roasted hazelnuts, chocolate powder or chocolate vermicelli. Finally, they are put aside to allow the chocolate to set.

As a substitute for the liqueur spirits, synthetic flavours may be used.

As the sugar is cooked to a temperature at which caramelisation begins to occur, the temperature given must not be exceeded, otherwise resultant nut pastes acquire an unpleasantly strong burnt flavour. The batch must not be stirred during cooking in order to avoid granulation.

Nougatines

Fine granulated sugar	10 lb.
Chopped roasted hazelnuts	4 „
Vanillin	¼ oz.

The dry sugar is placed in a cooking pan on a gas-fired stove. The sugar is heated at low pressure, stirring constantly, until completely dissolved in its own water of crystallisation. Care should be taken that every grain is dissolved and that the sugar

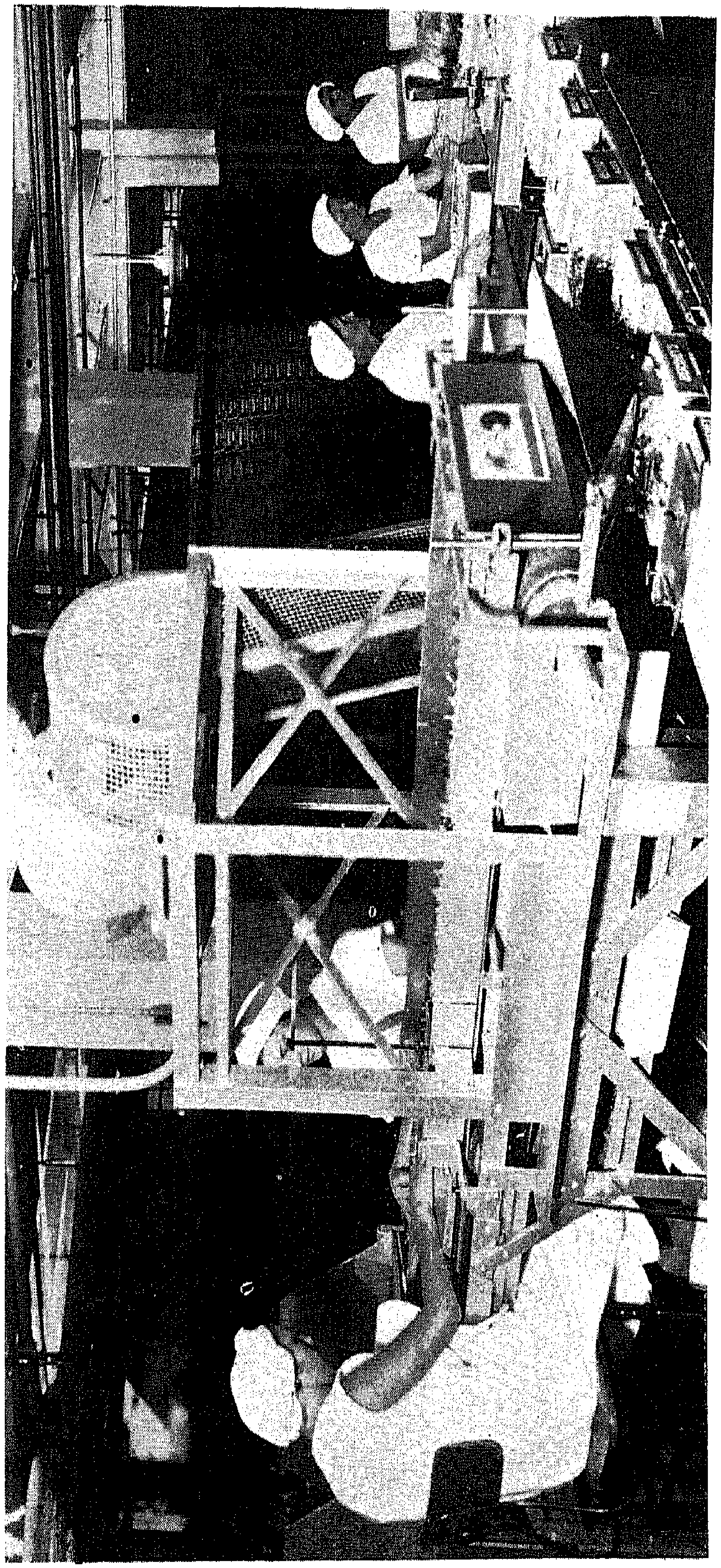


FIG. 68.—SORTING AND WEIGHING CANDIES.

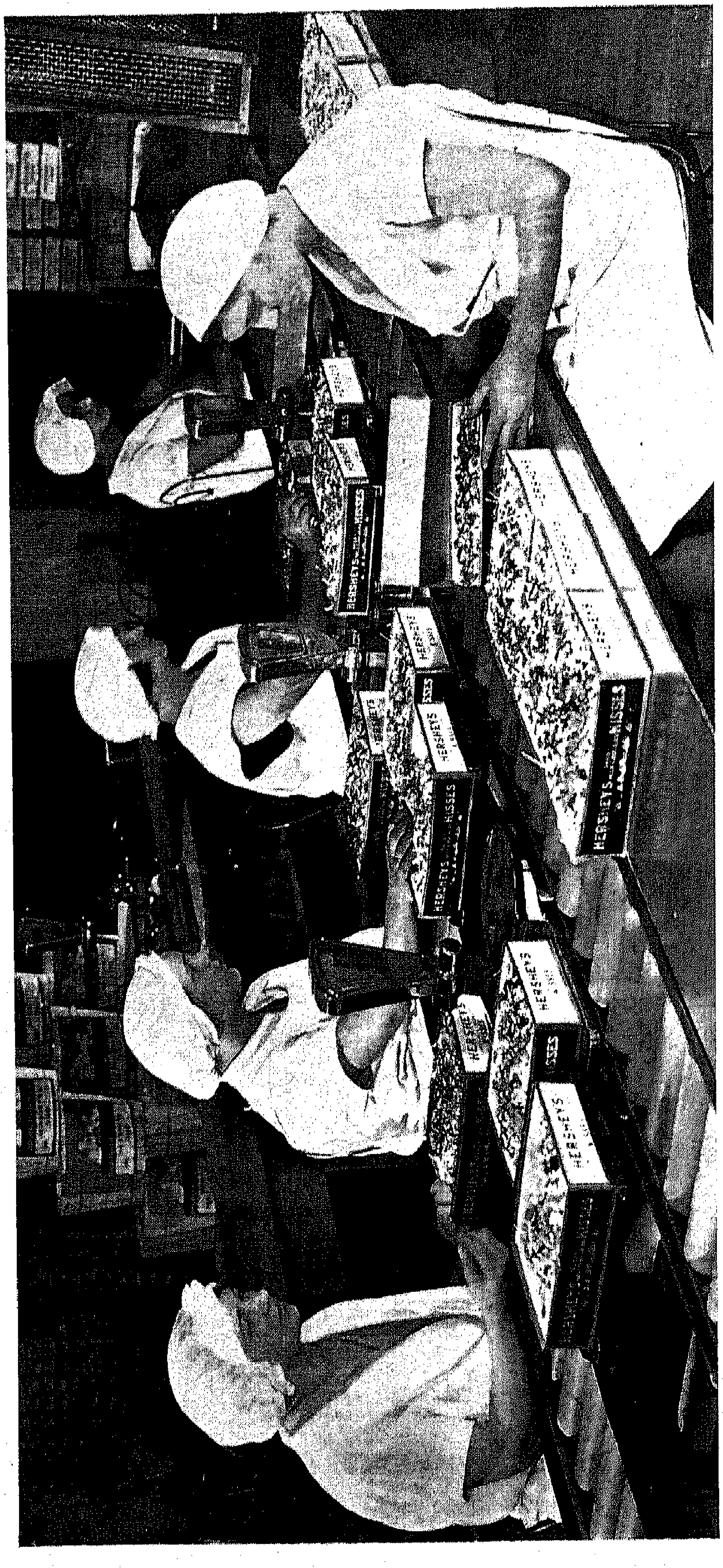


FIG. 69.—WEIGHING CONFECTIONERY INTO CONTAINERS ON A CONVEYOR.

does not burn. The chopped hazelnuts, previously warmed in a drying stove, are added and mixed thoroughly, and the batch poured on an oiled cooling slab. The vanillin is added and kneaded into the batch. When sufficiently plastic to handle, it is passed through drop rollers to form any desired shape. When cool, the centres should be coated with chocolate as soon as possible. Nougatines are highly hygroscopic.

Imitation Nougatines

Granulated sugar	28	lb.
Corn syrup	18	"
Chopped roasted hazelnuts	20	"
Vanillin	½	oz.
Water	1	gal.

The sugar and corn syrup are dissolved in 1 gal. of water in a cooking pan and cooked to 292°F. The chopped hazelnuts are added and mixed thoroughly. The batch is poured on a cooling slab, the vanillin added and kneaded until sufficiently plastic to pass through drop rollers. When cooled the nougatines are coated with chocolate. If the nougatines are not coated immediately, they should be stored in well-sealed containers to protect them from the atmosphere.

CHAPTER XVI

FACTORY ORGANISATION

Factory Planning

WHETHER a new department or new factory is being planned, the building construction and plant lay-out should be considered as a comprehensive whole. Hasty planning costs money in unnecessary movement and transport; in loss of efficiency due to ill-planned illumination; in excessive cleaning; material and fuel losses. The first thing to be considered when planning the site of a new factory is its proximity to incoming and outgoing rail traffic, and the possibility of having a railway siding to serve the factory. It should be easily accessible to its personnel, and well serviced by public utilities. The building itself must be planned to make full use of gravitational conveyance of material.

In order to reduce cleaning costs and eliminate accumulations of injurious dust, right-angled corners should be avoided; this applies to walls, floors and ceilings. The installation of air-conditioning plant during construction is an essential factor, as continuity of production and process standardisation can be maintained uniformly through all seasons. This applies equally to the raw material stores, where materials which are affected adversely by humidity, insect-infestation and heat must be protected from such conditions. When planning the positioning of the actual plant, ample allowance should be made for free movement of internal transport, with lines of demarcation denoting the traffic lanes clearly painted on the floors.

Plant Installation.—The installation of the plant itself requires a great deal of forethought and motion study so that, where possible, no interruptions occur in process continuity, and loss of time and energy is reduced to an absolute minimum (Fig. 67). For instance, it is poor planning to install a chocolate-making plant on the ground floor of a multi-storied building and place the enrobing and moulding plant on the upper floors. In chocolate manufacture it is important to position various items of plant in such a way that the manual handling of material is eliminated or at least reduced to a minimum. With the development of automatic discharging attachments associated with chocolate machines, the transfer of the discharged material can be achieved by suitably designed mechanical conveyors. In its liquid form, chocolate can be conveyed to and from any unit of plant by pump-actuated, thermostatically controlled, water-jacketed pipes.

Streamlined Plant.—All plant, whether for chocolate or confectionery production, should be streamlined, which means that not only should the external casings be angle-free, but angular joints avoided, where possible, in the internal mechanism. Streamlining is a deterrent to the accumulation of material in the plant, and assists in maintaining a high standard of hygiene in production. The future trend in plant will be simplification of design so that both operation and maintenance will be rendered easier (Fig. 70).

Several British, American and Czech confectionery plant manufacturers are taking positive action in this matter, which is of the utmost importance to confectionery and chocolate producers in all countries.

Motion Study.—The importance of undertaking a motion study of all manual operations involved in production cannot be stressed too strongly (Fig. 68). Movement reduced to a minimum obviously reduces fatigue, and where mechanical means cannot be used to achieve this condition, planned arrangement of work-in-progress or finished goods will attain the required degree of efficiency. Where practicable, cooling slabs should be mobile—that is, mounted on rails—so that they may be passed directly beneath elevated boiling pans and mixers to receive their charges of material. This eliminates manual handling of the masses involved. No opportunity should be lost in introducing conveyor-line packaging. This system not only increases production but simplifies operation and conserves floor space. This statement may sound like a platitude to those who for many years have had installed such continuous systems and other labour-saving devices, but it is surprising how many producers are still dissipating valuable man-energy by inefficient plant lay-out. We have still a long way to travel to reach absolute perfection (Fig. 69).

Safety Measures.—In Great Britain the Factories Act (1927) made the adequate safeguarding of dangerous parts of machinery compulsory, and subsequently all machines were fitted by the manufacturers with well-planned guards over moving mechanism, and devices which automatically prevent the starting of machines until the safety guards are in position. Even so, it still devolves upon the management to educate the machine operators to respect safety devices designed for their protection, and to ensure that familiarity does not breed contempt, which is often the case. It is a wise precaution to paint machines in graded colours, the most outstanding and contrasting colour, such as white or cream, nearest to the area of danger, and to inculcate in the mind of the operator the association of that particular colour with the danger point of the machine. Another system is the use of a selenium-cell attachment to stop a machine should the beam be broken by the hand of the operator crossing into the danger area. This would operate successfully in the case of direct-drive machines, where the momentum of a flywheel does not give continued impetus to the driving shaft. Where several machine units are motivated by a common driving shaft, mechanical safeguards are necessary. The modern tendency, however, is toward individual direct-drive, so that when a machine is not in use, the power is switched off.

Plant Maintenance.—The maintenance of plant in a high state of operating efficiency has always called for considerable technical skill on the part of the engineering staff, but never so much as the present day. So much depends on these plant physicians for the smooth, uninterrupted flow of production that their knowledge of the technical intricacies of modern machines and auxiliary plant governing working conditions, and their technical training, must be of the highest order.

Scientific Influence

Science is introducing new methods of control of machines and products into the food industry in the form of application of incessant scientific discoveries to these factors. Electronics, X-ray, ultrasonics, infra-red and ultra-violet rays, photoelectric cell and a host of other physical and chemical phenomena are being applied to the chocolate and confectionery industry in every-increasing volume. Gradually the technique is being revolutionised. The maintenance engineering department of the food factory of the future will consist of technicians, each specialising in a particular phase, according to the changes made by scientific influence. This applies more forcibly to factories situated in countries other than that from which the machinery originates. It is appreciated that proximity to the point of origin has the advantage of having the benefit of rapid service from skilled technicians of the plant manufacturer.

Laboratory Control.—It is advisable that each food factory should possess its own laboratory and food chemist, or, at least, a consulting chemist on whom it can rely for guidance. The production of waste and faulty goods is due either to negligence, lack of knowledge and skill, imperfect plant, or unsatisfactory raw materials. There are instances, of course, such as the end pieces of hard sugar rocks, machine cuttings and pan scrapings, where such waste is unavoidable. On the whole, however, waste can be reduced to a minimum by proper laboratory and operational control. It must be pointed out that, other than skimmings from batch surfaces, all waste can be reprocessed into palatable form.

Plant Hygiene

The scrupulous cleanliness of candy containers is a factor of the highest importance, therefore organised inspection of such containers should be planned at different stages of work progress.

First, no faulty or contaminated containers, particularly returned glassware and cans, should reach the washing plant. Preliminary inspection will eliminate cracked and chipped jars and imperfect cans. It will also see that no containers contaminated with foreign materials which cannot be easily removed—*e.g.*, paraffin—are passed into the soaking tanks. A secondary inspection will ensure that the washed containers are properly rinsed and dried before being filled with goods. Secondly, ultimate inspection of the finished packaged goods is a necessity, both from the contents and the container-perfection points of view. This inspection is accomplished in several ways, the usual method involving the passing of the packs, unsealed in the case of cartons and boxes, on a conveyor through an illuminated cabinet, in which the inspector examines each pack. This method, however, does not allow the inspection to be made of the interior of the pack, and occasionally the presence of a foreign body will prompt a consumer to return, indignantly, the offending piece.

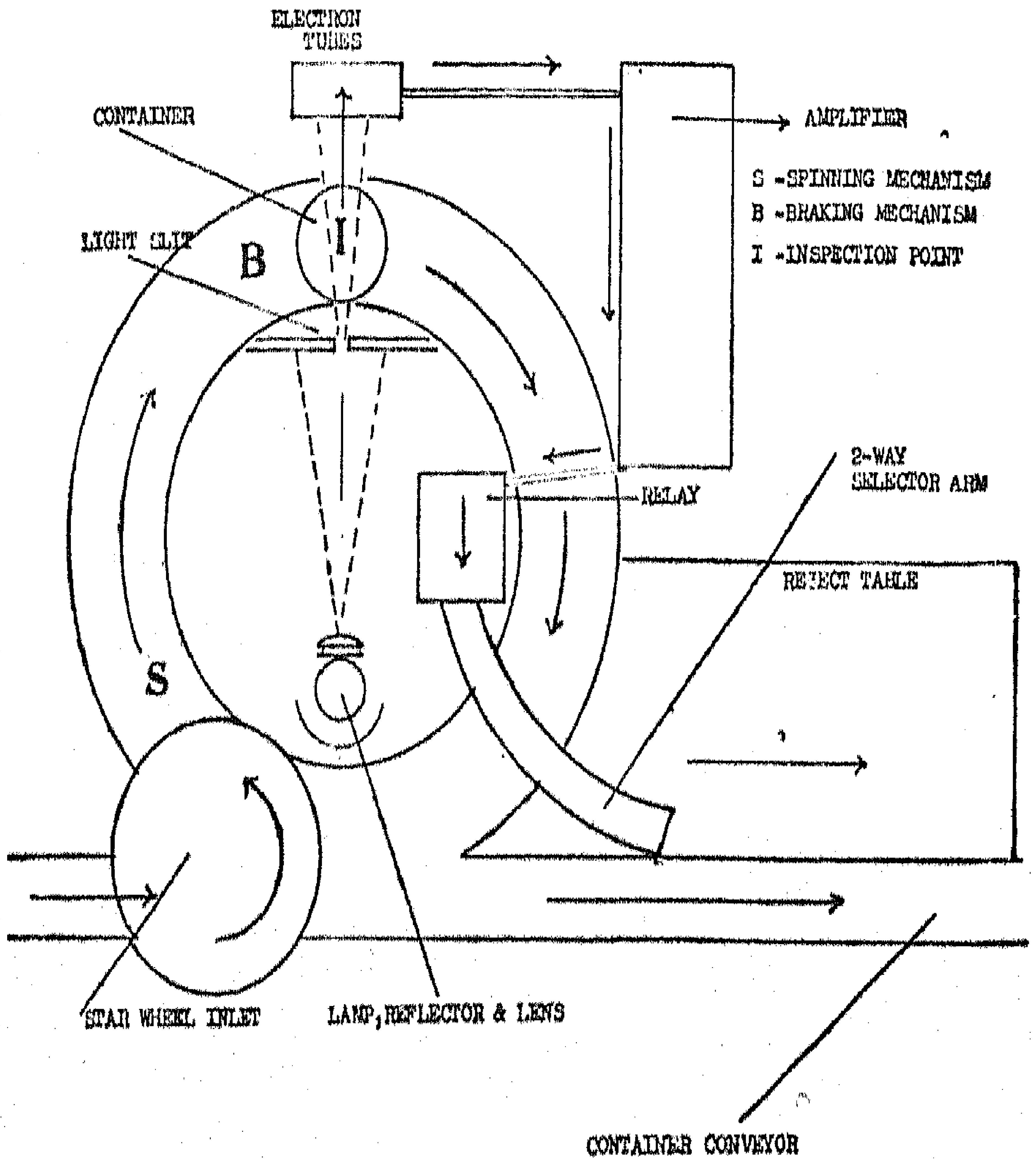


FIG. 70.—ELECTRONIC INSPECTION UNIT.

Electronics.—Great strides are being made in the perfection of electronic inspection devices, which detect the presence of unusual bodies and automatically reject the container. A beam of light is passed through the container under inspection, and impinges on a set of electron-tubes. If any change occurs in intensity of light through the presence of unusual bodies, a minute change in potential is engendered by electronic amplification, and this change is magnified sufficiently to motivate a relay mechanism on a two-way selector arm (Fig. 71). Under normal conditions, this arm returns the packages to the conveyor band. If, however, a change takes place in the light intensity, the arm moves and causes the rejected unit to pass to a rejection table.

The development of electronic devices for the purposes of inspection, defestation and sterilisation is still in its early stages, and is inapplicable to general use. It is, however, only a matter of time before electronics will play an extremely important part in the chocolate and confectionery industry.

Radio Frequency Heating.—Radio frequency heating is being developed to bring about the elimination of eggs and larvæ in dried fruits, since these organisms, which are a great nuisance to the discriminating manufacturer, are more readily killed at temperatures that do not injure the product. The fruit is passed through a specially constructed radiant heat tunnel in which it is subjected to the required temperature for a period of 12 minutes, during which time the fruit is effectively cleared.

X-Rays Inspection.—The use of X-rays (Fig. 70) as an inspection medium in the food industry is increasing as manufacturers realise the simplicity and effectiveness of the apparatus required. An excellent example of an X-ray unit for use in conjunction with a production conveyor system is the Philips Macro 100. This unit is capable of applicability over a wide range of food inspection problems. The apparatus is divided into three parts—a shock-proof and ray-proof X-ray tube, a H.T. transformer, and a control table. When used in conjunction with a conveyor belt along which the packages travel, the X-ray tube is positioned below the conveyor. The X-ray beam passes through the package, the resulting image impinges on a fluorescent screen and is reflected by a mirror set obliquely to suit the comfort of the operator. A simple trigger mechanism fitted to the bench in front of the conveyor allows the faulty packages to be rejected. The tube itself is cooled by a special slow speed 2-stage high-pressure blower; this is necessary in a conveyor set-up. In addition, safety devices are incorporated which ensure that the cooling system is always operating when the X-ray tube is energised.

Quality Control.—In addition to package inspection, it is essential for the laboratory staff to undertake a series of exhaustive tests on the finished chocolates and confectionery in order that they may check the quality and shelf-life of the products. Tests should be made to observe the reaction of the goods to the varying atmospheric conditions to which they are subject in the windows of retail stores. It is suggested that a great deal has been left undone by manufacturers in the education of retailers in the matter of conditions under which chocolate and confectionery are displayed. If such advice is not extended, the intensive precautions undertaken by the manufacturer to produce the perfect article are nullified.

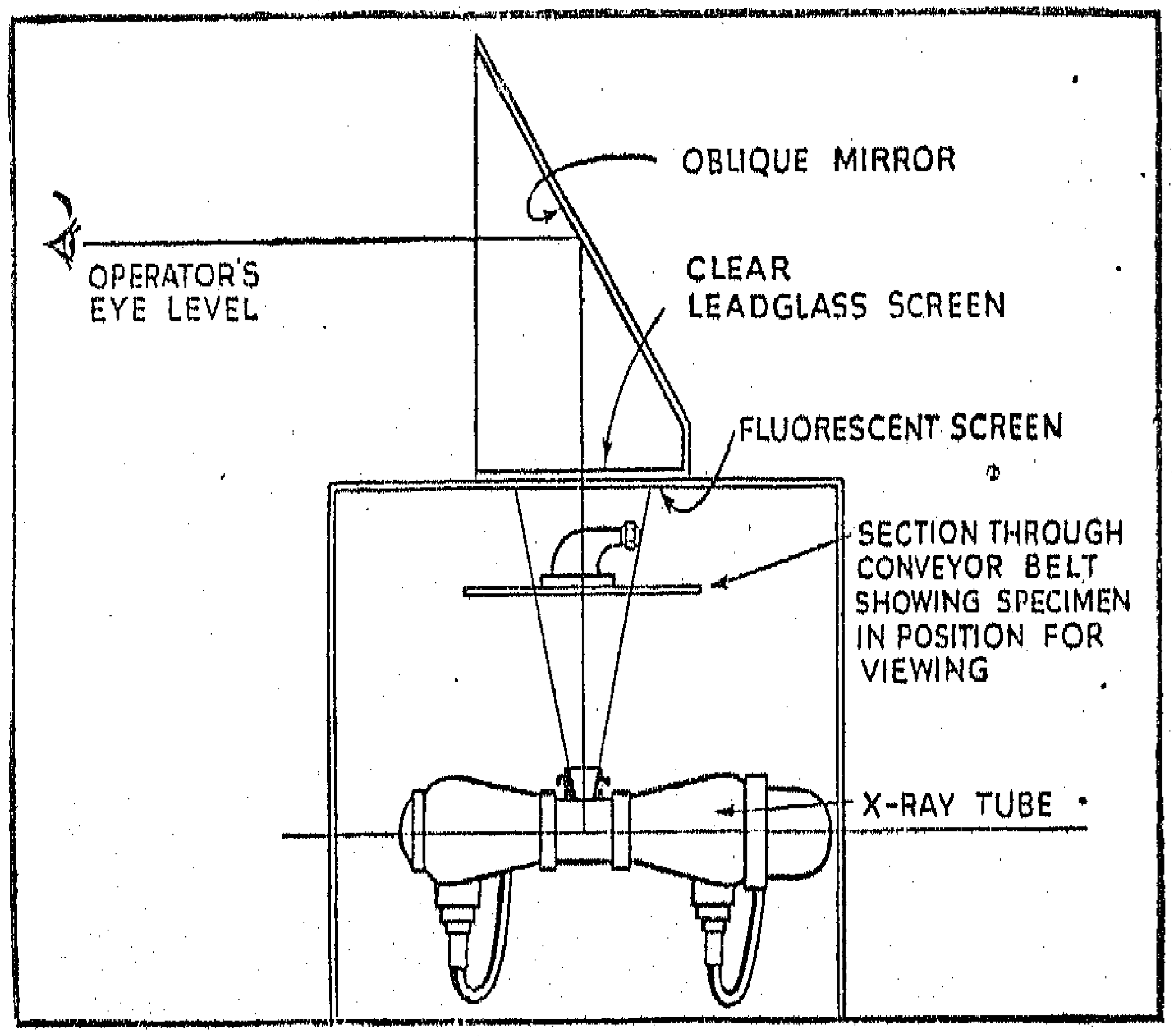


FIG. 71.—MACRO 100 INSPECTION UNIT.

Production Planning.—Another important phase is planning for production. This activity should be the responsibility of executives especially selected and trained for the work. Their duties cover the planned influx of raw materials in calculated quantities to each department so that no deficiencies or surpluses will occur; the co-ordination of production and

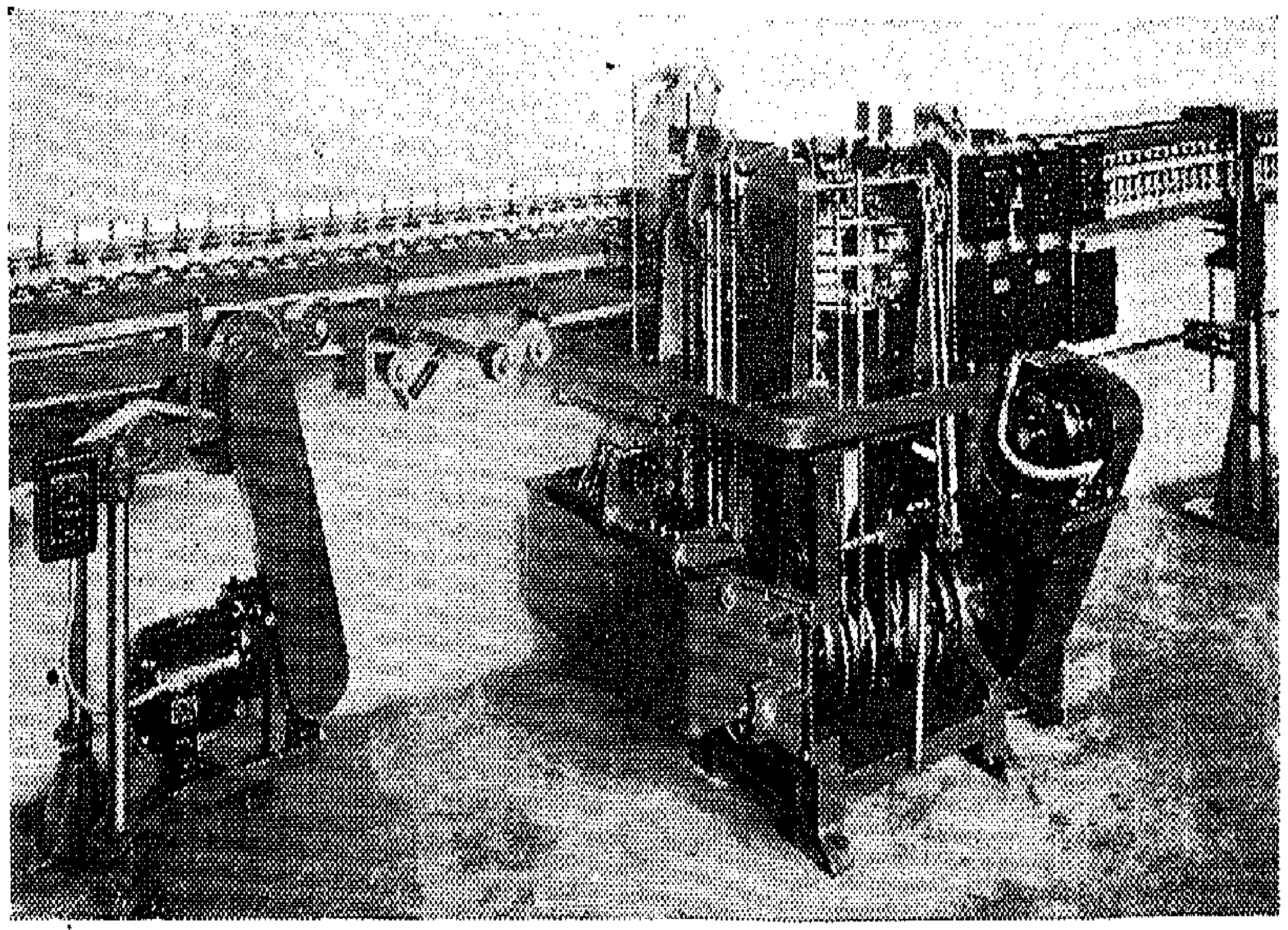


FIG. 72.—ROTARY TOP CLOSURE MACHINE.

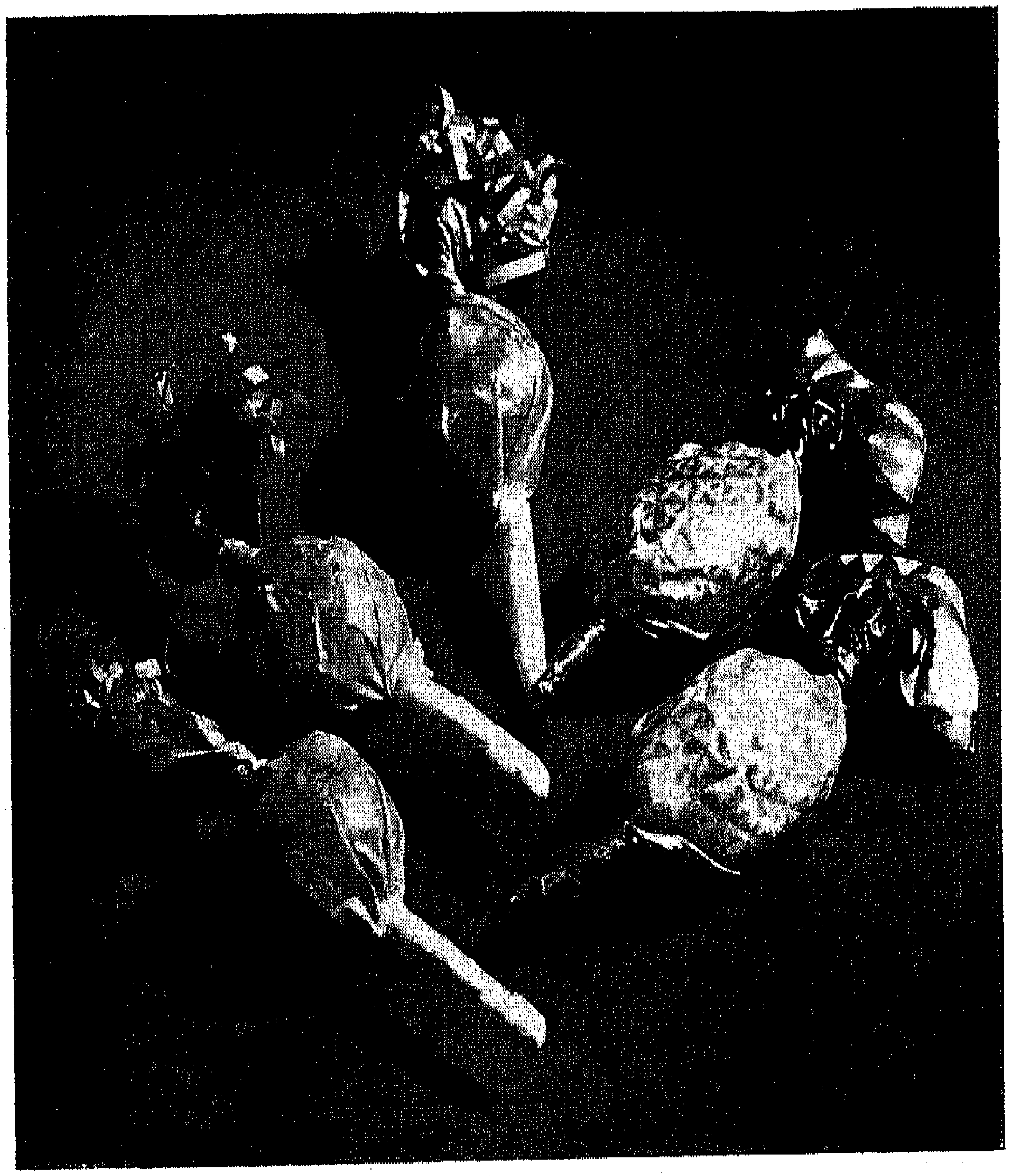


FIG. 73.—SWEET RADISHES AND PINEAPPLES.
Example of combined twisting and folding machine work.

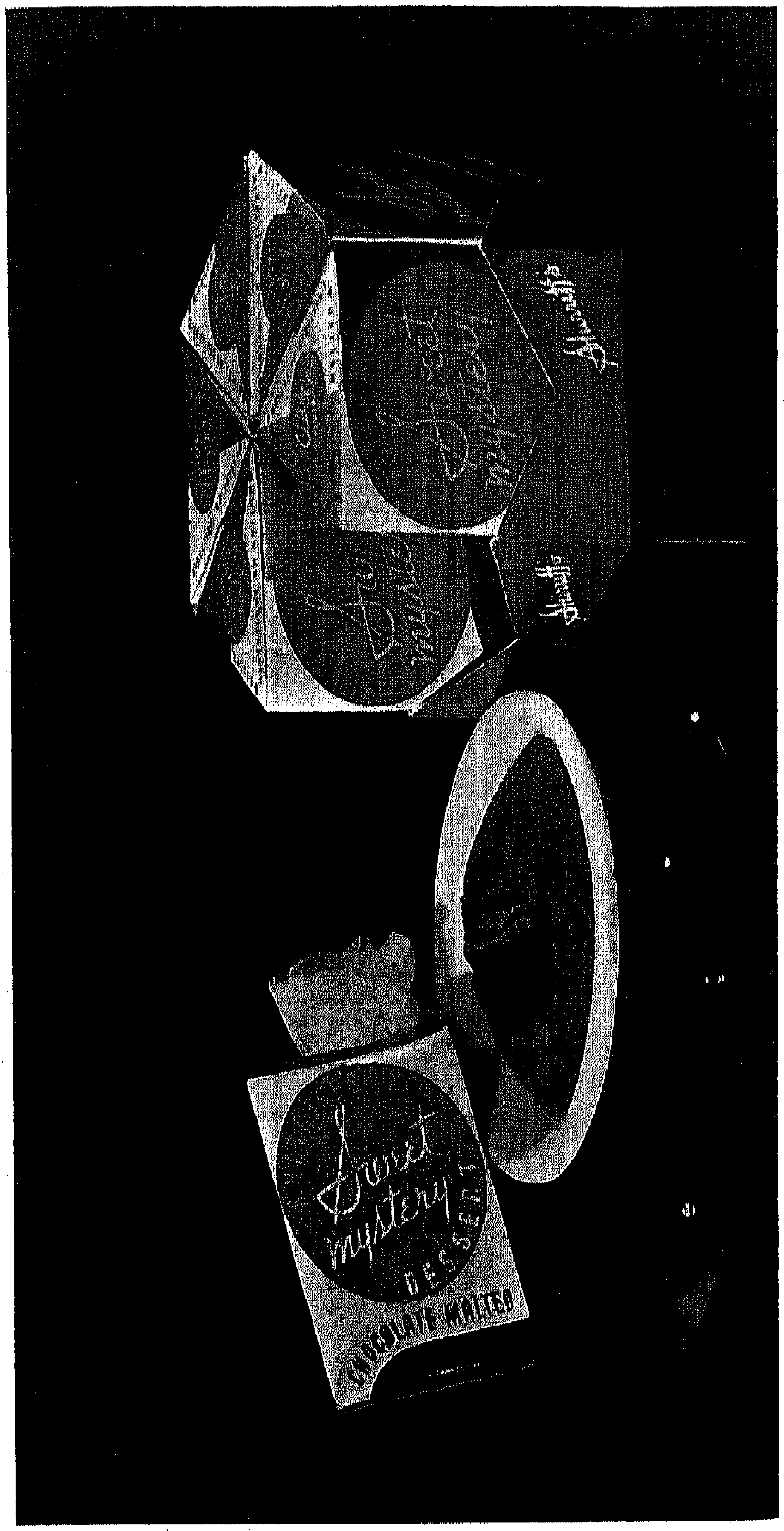


FIG. 74.—AN IMAGINATIVE CARTON DESIGN.

sales; the transfer of semi-finished work from one department to another; and the distribution of personnel and the supply of adequate packaging and wrapping material to their appropriate destination. On the efficient operation of the planning department depends the sustained continuity of the organisation. There are many types of production control systems which provide visible recordings of the state of work-in-progress, and these should be utilised by the planning department to the fullest extent, since the elimination of bottle-necks, losses of production time through ill-timed requisitioning, and uneven progress of materials can be avoided only by up-to-the-minute knowledge of the state of affairs in the factory.

Influence of Colour

Increasing attention is being given to the relation of colour to industrial efficiency. In the past, machine units have been finished by plant manufacturers with a coat of dark or semi-dark paint so that the surfaces should not emphasise chocolate or confectionery deposits made upon them by soiled hands. In some cases, the manufacturers have had æsthetic reasons for the colour they adopted, but only rarely did they deviate from the darker shades. Today, the matter of the colour of machines is of primary importance, since there are several factors on which colour has a direct influence.

First, is the effect bright clean colour exerts on the personnel in the factory; secondly, light reflection from machine surfaces; thirdly, the increased incentive to cleanliness and hygiene. Cream is the colour being almost universally adopted for the modern machine in the food factory. It is the type of colour naturally associated with food manufacture, because it gives the impression of lightness, as opposed to the heaviness suggested by dark-coloured machines, and, therefore, exerts a distinctly uplifting influence on the personnel who spend most of their waking hours amongst machines. The walls and pillars of the modern food factory are coated with glossy cream or white paint to obtain maximum light reflection. This condition also applies to the surfaces of the plant, since reason dictates that the light reflected from the walls and ceiling must not be absorbed by dark-coloured plant. Food machinery manufacturers have reasoned this way, and the change-over to cream finish of high reflective value is steadily becoming general.

White is not a good colour for machine finish. It is psychologically cold, and for that reason it is lower in the scale of colour stimulation values than red, brown or green.

A cream-coloured machine shows a stain on its surface immediately, and the natural reaction of the operator is to eradicate that blemish so that his charge will look bright and clean. The general standard of hygiene throughout the factory is raised very considerably if the plant visibly justifies the energy and care spent by the operators on maintaining it in a clean condition.

Air Conditioning

Air-conditioning in a chocolate and confectionery factory is an essential factor for the maintenance of constantly favourable atmospheric conditions which will allow standardisation of process control. An artificial climate is permanently created, and adjustments of control factors, which are usually necessary to meet changing temperature and humidity conditions, are no longer required.

The conditions engendered by an air-conditioning plant are constant air movement, control of humidity, temperature, purity and freedom from suspended particles (Fig. 75). In this plant, a fan draws fresh air through a water-spray washer, discharges it through a heating battery, and finally distributes the conditioned air throughout the factory by means of a series of ducts. The plant is automatically controlled, the control apparatus being operated by compressed air from temperature regulators and by a humidity regulator, so that once the plant is adjusted for a given temperature and humidity value, internal air remains constant (Fig. 76).

If steam and heat from the cooking units are allowed to escape freely into the atmosphere of a processing department whilst an air-conditioning system is installed to control the air, the object of the latter is being defeated. It is, therefore, essential to segregate the cooking units by means of partitions,

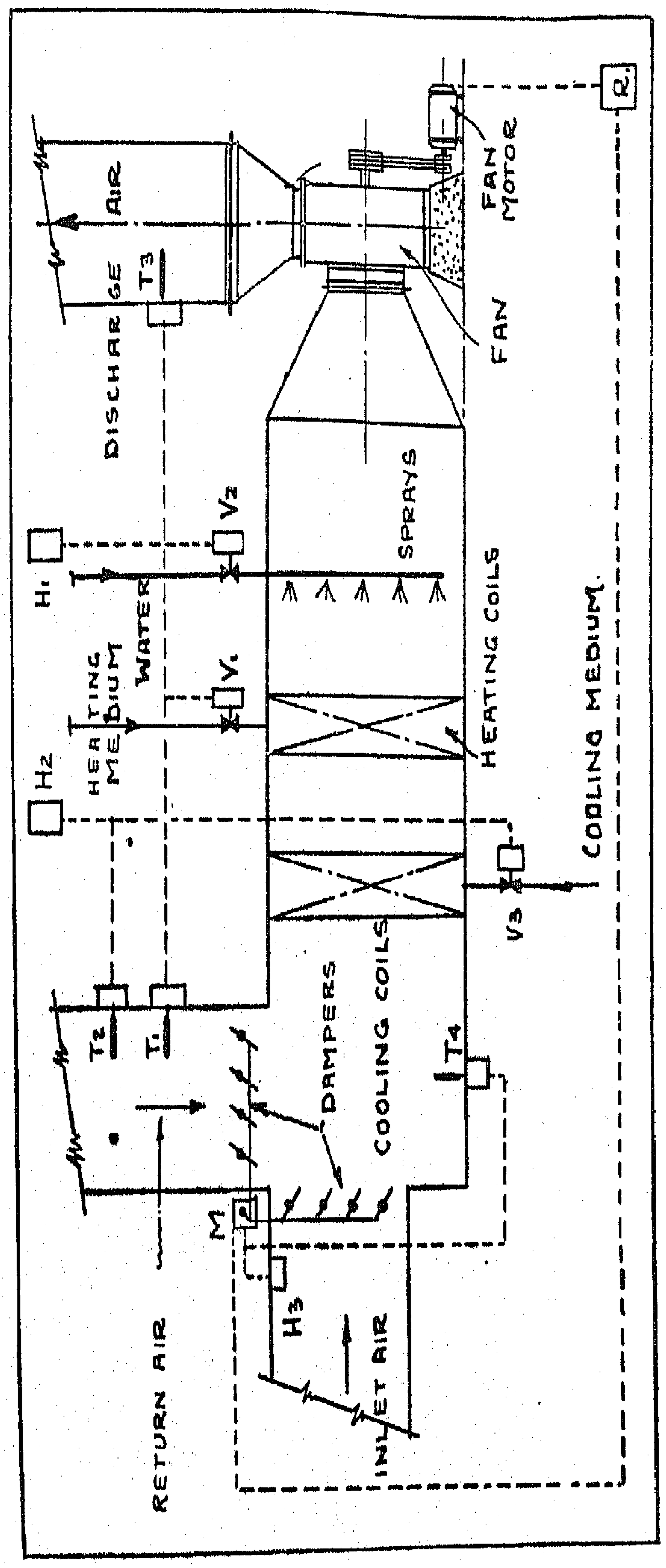


Fig. 75.—Air Cooling System.

and to fit all open cooking vessels with exhaust hoods so that steam and as much as possible of the heat is drawn off by fans into the outside atmosphere.

Human Factor.—Another tremendously important advantage of air regulation in the factory is the creation of ideal conditions for the personnel. It is a well-known fact that, during the summer months in temperatures above 80°F., human efficiency decreases with an attendant loss of concentration. In a climate artificially maintained at a constant level, the increase in individual productivity will quickly recover the initial cost of installation of the plant.

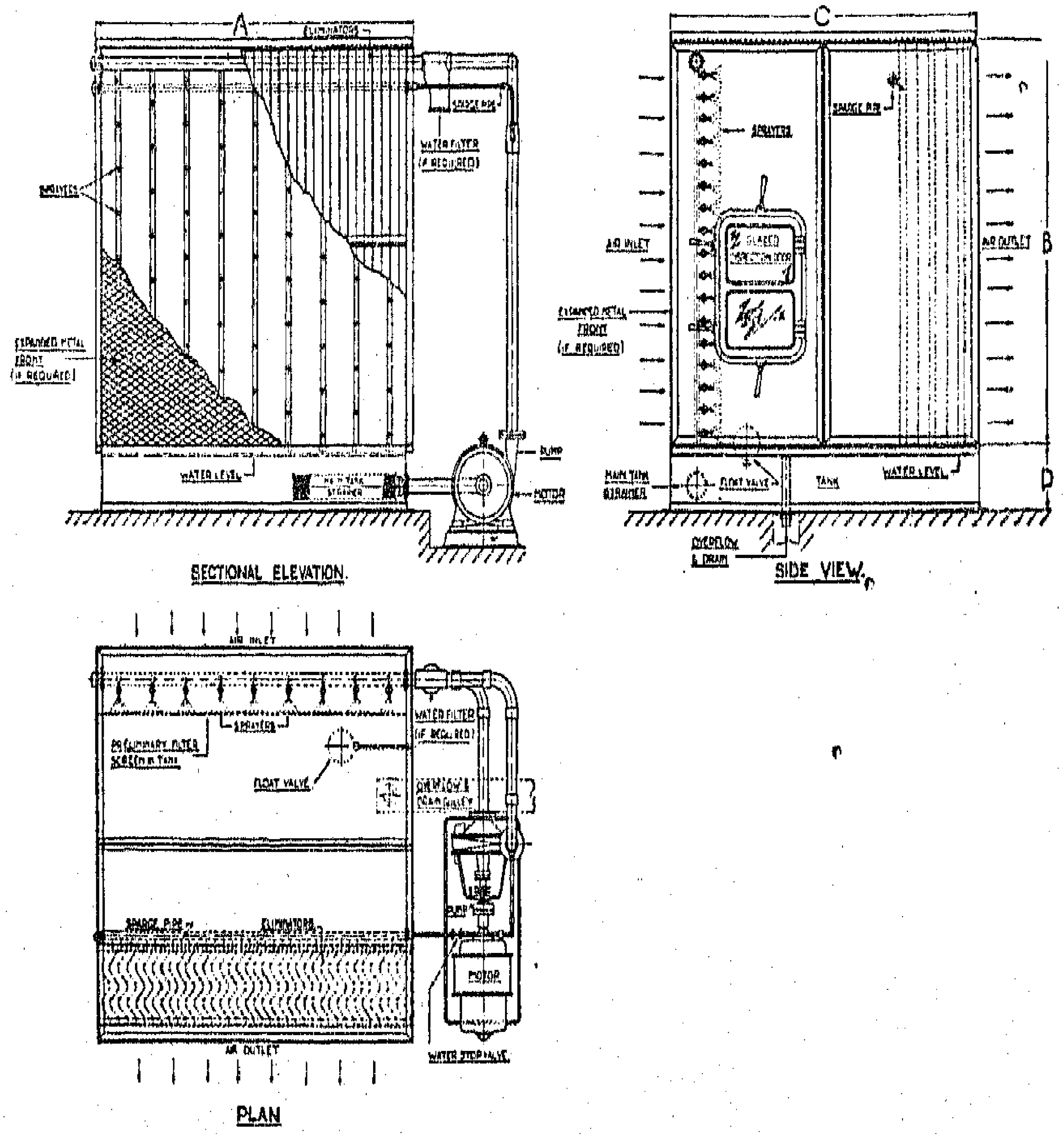


Fig. 76.—Air Washing Plant.

Delivery

The manufacturer is responsible for his own products right up to the point of consumption. Quite often, one finds the conditions of delivery of goods from the factory to warehouse or shop treated perfunctorily, and the packages handled without consideration of the time and thought spent on the perfect presentation of the merchandise. Chocolates may be rubbed, soft jellies crushed and crystallised surfaces spoiled, conditions which detract from the shelf-appeal of the products and may reduce their shelf-life. No effort should be spared to ensure that delivery vehicles are constructed so that packages reach their destination in the same state of preservation as they leave the factory. Racks built in the sides of the vehicle will prevent breakage of the larger glass containers, and suitable adjustable partitions will prevent packages sliding owing to vehicle vibration. Whilst it is appreciated that the manufacturer has no control over the delivery and storage conditions of the middle man, he can, however, tender relevant advice regarding the proper handling of his merchandise to the wholesale agent through association channels.

CHAPTER XVII

RESEARCH

According to the old adage, there is nothing new under the sun. There is, however, an infinity of possible variations on any one theme, and it is to the divergent conceptions of the chocolatier, confectioner, food chemist, packaging and mechanical experts that the industry owes its multitude of interesting products.

New Materials.—As each fresh raw material is discovered or isolated by the research chemist, a new line of experimentation is indicated to the practical man who, having been advised of the potentialities of a material, proceeds with an unending series of empirical tests. These experiments bring forth new or better types of confectionery involving different conditions of production and presentation (Fig. 73). If the supply of a raw material decreases or ceases altogether, a substitute is evolved, and the process is repeated. This evolution may bring about many changes in accepted standards of quality, flavour, texture and manipulation.

We have already the example of the discovery of transparent plastic material which provides a new packaging medium for the confectioner. A possibility of the future may involve the use of an edible, moisture-proof film sprayed on confectionery to eliminate the necessity of wrapping media.

Hydrogenation.—The process of hydrogenation opened up new fields of exploration when hard fats of increasingly high melting points were produced. As the melting point of a fat used in confectionery increases, so does the texture and degree of masticity change. For example, the incorporation of a fat whose melting point lies between 120° and 130°F. in a creamy toffee formula would alter its character considerably, and give rise to possible interesting modifications. Extractions of the higher melting point fractions of cacao butter for use in chocolate would probably enable the chocolatier to produce chocolates impervious to bloom even under tropical conditions.

Plastics.—Modern synthetic plastics find application in the manufacture of chewing gum. Lougoyov's U.S. Patent 2,412,590 describes such a synthetic product, which demonstrates the illimitable field yet to be explored in the search for new raw materials.

Whey Concentrate.—The introduction of whey concentrate, with its high lactose content as a confectionery raw material, was due to the war-time shortage of condensed milk. Whether it could replace condensed milk is a very doubtful point, but the product is a potential factor to be studied in relation to its application to confectionery manufacture on account of its emulsifying property.

Food Values.—In the U.S.A., research chemists are applying themselves diligently to the question of increasing the food value of confectionery. A wide range of natural products are being investigated; soya, groundnut, sunflower seed oils, pectins and yeasts are examples. Such research is important insomuch as its results will further enhance the status of chocolate and confectionery in the mind of the consuming public, although incessant propaganda will always be necessary to create the right impression. Even in these enlightened times, a large mass of the public harbours erroneous ideas as to the purity of the raw materials used in certain types of confectionery, a prominent example being licorice confections. Public education, therefore, is essential to implement the work of the research chemist.

Dextran.—British research chemists are carrying out a series of investigations on a sweet substance called dextran, which is excreted by bacilli found during the refining of sugar. The resultant dextran syrup is of pale amber colour, and has been found to possess certain emulsifying properties which may later be adaptable to confectionery manufacture.

Package Design

The planning of a new package demands the most diligent consideration of the potential reaction to colour and design of the particular market in which the manufacturer is interested. People of different nations and in different climates react to colour according to their native character and environment. For instance, in tropical countries vivid colours might be employed to advantage in package design: the design itself richly and boldly conceived to match the nature of the inhabitants in their vivid natural surroundings. In modern times the development of the department store has exerted a powerful influence in design and presentation. This high-powered selling system affords an ever-increasing market for chocolate and confectionery products, and for such markets the design should incorporate a pictorial representation of the package contents with a delicately handled colour scheme (Fig. 74).

In the department store, the potential customer is confronted with a massed display of different packages, many bearing well-established names. Invariably these names are distinctively displayed on the packages, leaving no room for doubt as to the manufacturer. This is an important point for every manufacturer, however small, to remember. If the quality of his product is equal to or surpasses that of the established brands, then the smaller manufacturer must ensure that his package presentation is more artistically striking than his powerful competitors. He is fortunate in being able to enlist the services of the many highly trained package designers now practising in every country. The incorporation of a pictorial description of the contents assists the customer to make a quick selection in the limited time available to view the display. Meaningless decorations should be avoided, since they tend to confuse the purchaser. The adoption of a symbolic device to be used in constant association with a manufacturing house can be an excellent means of impressing a range of products on the public mind (Fig. 77).

Colour Scheme.—Legibility of print and correct colour combination selection are of the highest importance to the selling power of a package. It must, moreover, be remembered that subtle gradations of tone in a package colour scheme do not register with the average public. The package bearing such a design would also fail to distinguish itself when displayed with other distinctively designed merchandise. The colours employed and the pictorial design should be intimately asso-

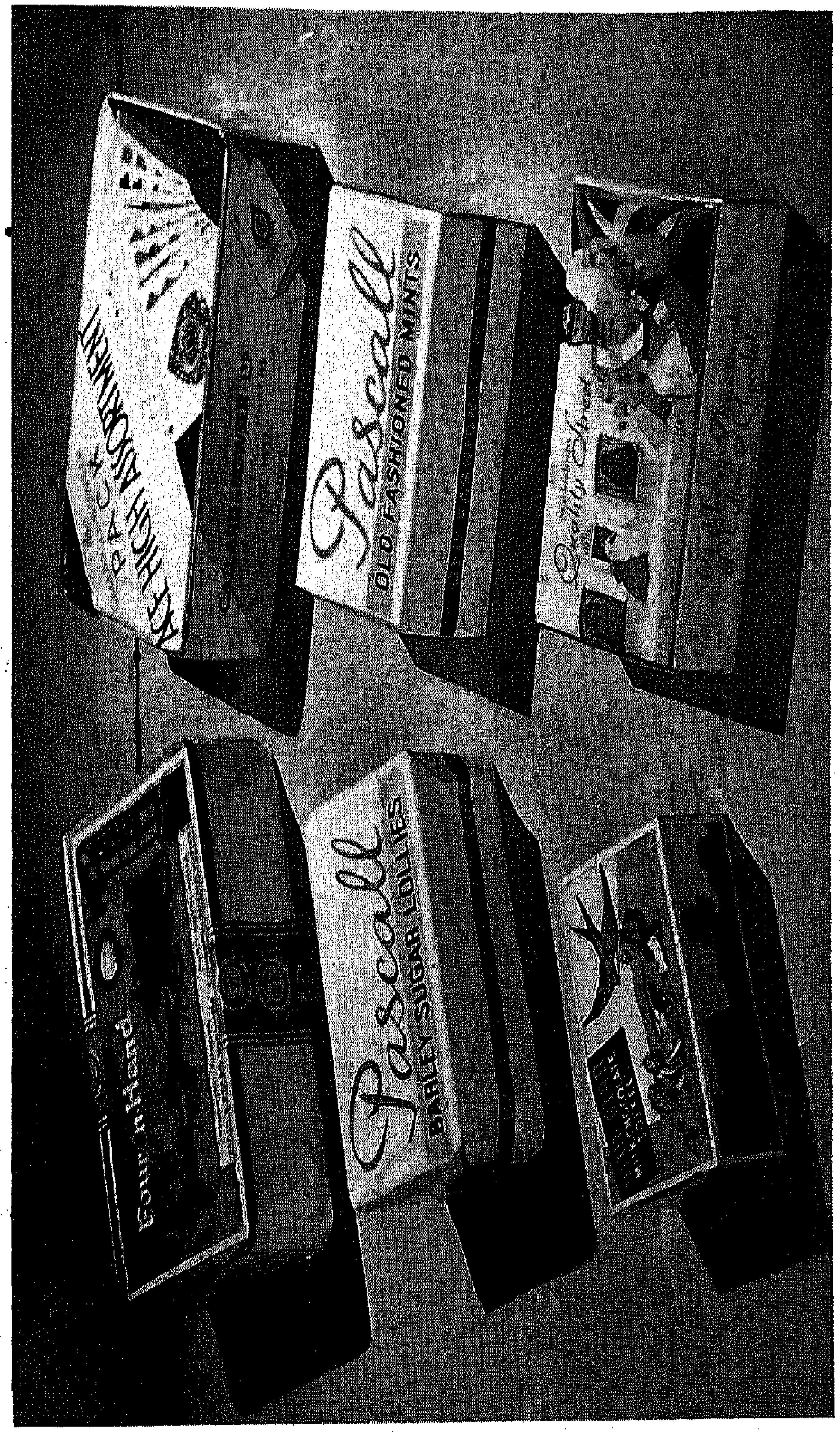


Fig. 77.—Distinctive Package Designs

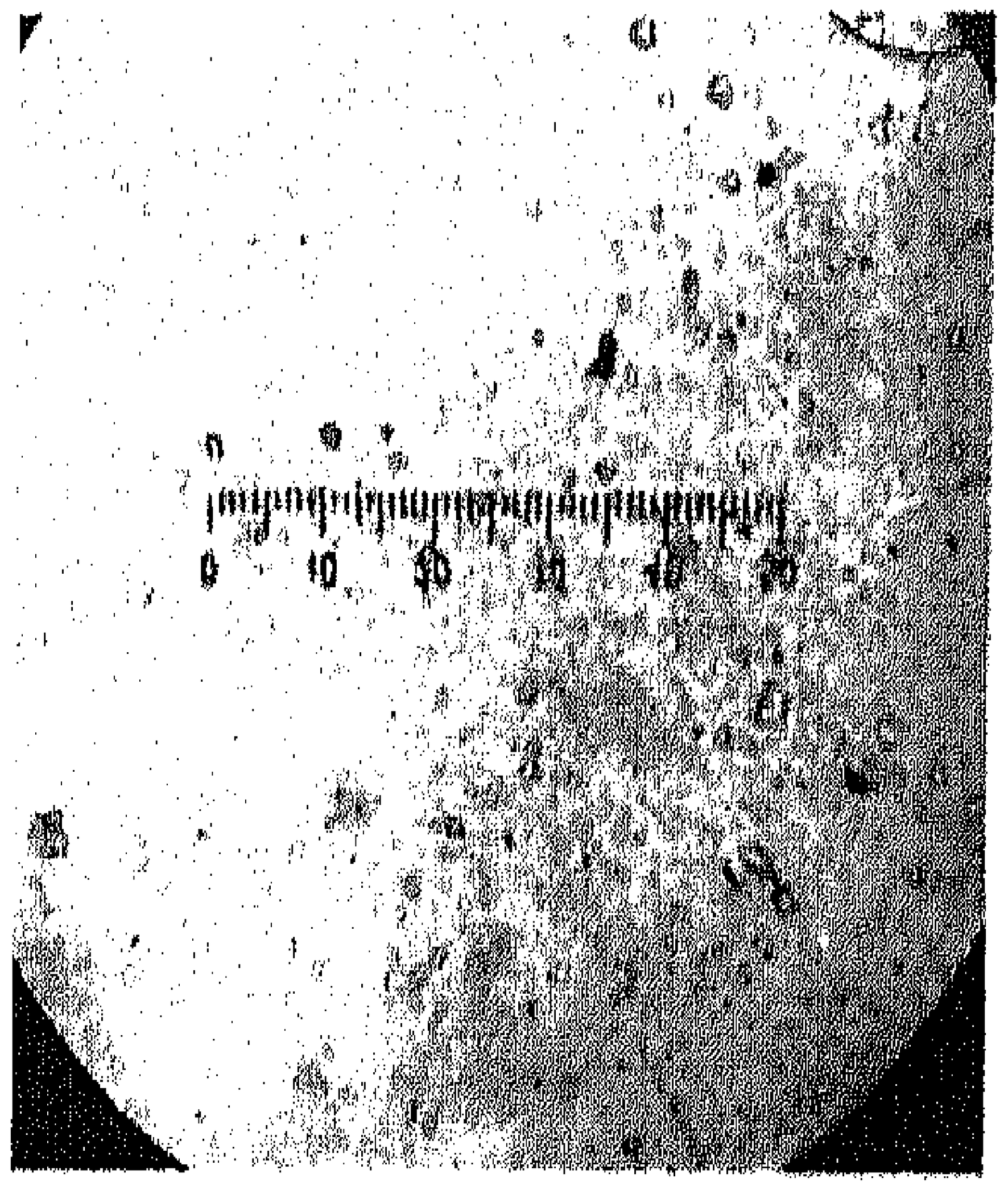


FIG. 78A.—MICROGRAPH OF CHOCOLATE MASS TREATED IN LONGITUDINAL CONCHE.

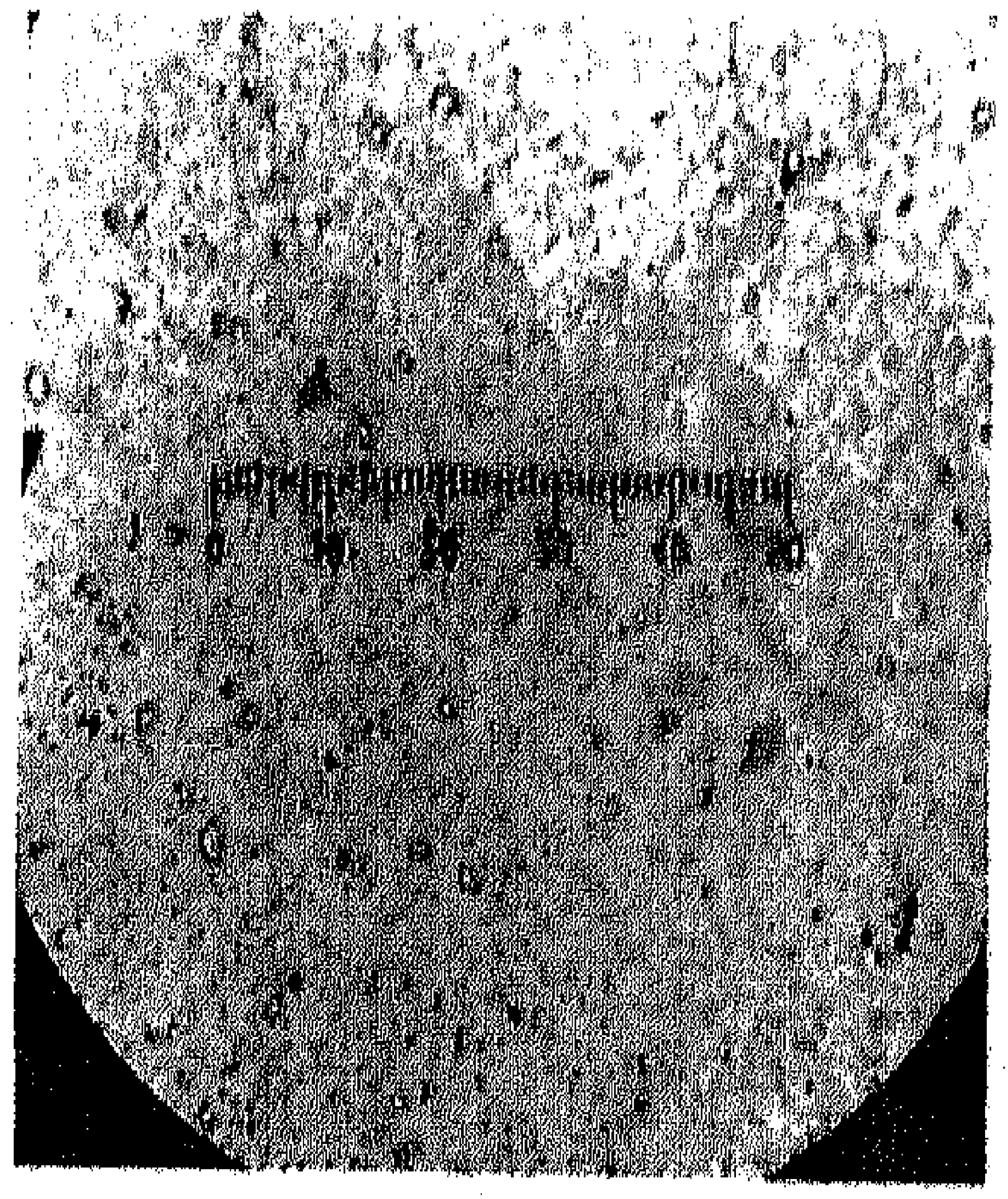


FIG. 78B.—MICROGRAPH OF CHOCOLATE MASS TREATED IN ULTRASONIC CONCHE.

ciated with the contents of a package so that the instantaneous visual impression gained by the potential customer is one of palate-attraction.

Pre-packaging

As the tempo of modern living increases, the sales trend is inevitably toward packaged merchandise. The retailer prefers merchandise which eliminates the time-consuming task of weighing with its possible attendant loss on the turn of the scales. With the packaged line he suffers no loss due to exposure to unfavourable atmospheric conditions, which so often happens in the case of bulk goods. As an example of the extent of this evolution, statistics published in the U.S.A. show that over 80 per cent. of the chocolates and confectionery produced in that country consists of packaged and count goods. The rapid development of high-speed wrapping and packaging machinery is primarily responsible for this condition, which possesses the virtue of affording essential protection to the merchandise.

Package Research

In this connection, extensive research is being undertaken to improve the resistance of packaging materials to penetration by various external influences, and to study methods of minimising insect and mould attack on packages intended for export, particularly to tropical and semi-tropical countries.

Ultrasonics

The industrial application of high-frequency sonics and ultrasonics is exercising the minds of research workers in every country, and there is a high degree of probability that this branch of science will ultimately play an important part in the manufacture of foodstuffs and, in particular, chocolate and confectionery. It might conceivably revolutionise many of our accepted ideas on productive practice, and bring about a considerable reorganisation of existing technique.

Emulsification.—At this early stage of development we learn that certain physical and chemical changes are produced by the action of ultrasonic vibrations on solids and liquids; rapid emulsification of oils and aqueous solutions, particle comminution, maturing phenomena and expulsion of air or gases from liquid and semi-liquid masses, such as chocolate liquor, constitute a few of the possibilities. This branch of research affects the whole of the food industry, and far-seeing food and plant manufacturers would be well advised to watch the development of ultrasonics very closely since the indications point to possible reduction in production time and costs.

Particle Comminution.—Ultrasonic oscillations are produced by means of piezo-electric generators which employ quartz crystals as a medium. Piezo-electric oscillators are usually operated in the 300-400 kilocycle range. In the laboratory, the liquid under treatment, contained in a glass vessel, is placed in direct contact with the suitably mounted quartz crystal. A stepped-up electric current is passed through the generator and ultrasonic oscillations act directly on the liquid.

For the production of high-frequency sonics, magneto strictive generators, and acoustic devices based on the Galton whistle are being developed. The magneto strictive generator devolves upon the property of magnetic alloys to change their dimensions in the direction of an applied magnetic field. In this case the alloy takes the form of a hollow tube, artificially cooled to remove high-frequency heating, partially immersed in the liquid under treatment. Oscillations are set up in the tube by means of A.C. and D.C. currents, which are passed through a coil surrounding the external portion of the tube. These generators operate in the 10-25 kilocycle range.

Comparison of the particle comminution of chocolate treated in the patented ultrasonic conche of Nordenskjöld and Holmquist and the usual longitudinal conche is shown in the two micrographs (Fig. 78 A and B). Close examination will prove that there is no perceptible difference in the particle size of either specimen. This would tend to prove the efficacy of ultrasonic treatment in the matter of particle comminution in chocolate mass.

The mechanical device utilising the Galton whistle principle for the generation of high-frequency oscillations operates in the 15-20 kilocycle range, and is capable of emulsifying a liquid mixture in a few seconds.

Co-ordination of Research.—Provided the world is assured of a reasonable degree of international stability for a few decades, we shall see vast changes in industry, changes due entirely to the magnificent and untiring efforts of the research worker. Important steps have been taken to co-ordinate the activities of individual research chemists, physicists and engineers with those of the research associations attached to the various branches of industry in order to eliminate duplication of effort, and to enhance the advantage of close collaboration.

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APPROXIMATE METRIC EQUIVALENTS OF ALL ENGLISH MEASUREMENTS USED IN THIS BOOK

Weight.

English.	*Metric.*
2 drams (⅛ oz.)	3·5431 grammes
6 „	10·6293 „
¼ oz.	7·0862 „
½ „	14·1724 „
¾ „	21·2586 „
1 „	28·3448 „
1⅛ „	31·8879 „
1¼ „	35·4310 „
1½ „	42·5172 „
1¾ „	49·6034 „
2 „	56·6896 „
2¼ „	63·7758 „
2½ „	70·8620 „
2¾ „	77·9482 „
2 15/16 „	83·2629 „
3 „	85·0344 „
4 „ (¼ lb.)	113·3792 „
6 „	170·0688 „
8 „ (½ lb.)	226·7584 „
12 „	340·1376 „
14 „	396·8272 „
15 „	425·1720 „
1 lb.	·4535 kilos
1¼ „	·5669 „
1½ „	·6803 „
1 lb. 14 oz.	·8503 „
2 lb.	·9070 „
2 lb. 2 oz.	·9637 „
2½ lb.	1·1338 „
3 „	1·3605 „
3½ „	1·5873 „
4 „	1·8140 „
5 „	2·2675 „
5¼ „	2·3809 „
6 „	2·7210 „
7 „	3·1745 „
7½ „	3·4013 „
8 „	3·6280 „
9 „	4·0815 „
10 „	4·5352 „
12 „	5·4420 „
13 „	5·8955 „
14 „	6·3490 „
15 „	6·8025 „
16 „	7·2560 „
17 „	7·7095 „
17½ „	7·9363 „
18 „	8·1630 „
20 „	9·0703 „
21 „	9·5235 „
22 „	9·9770 „
24 „	10·8840 „
25 „	11·3375 „
26 „	11·7910 „
28 „ (¼ cwt.)	12·6980 „
30 „	13·6050 „
32 „	14·5125 „
35 „	15·8725 „
37½ lb.	17·0063 kilos
38 „	17·2330 „
39 „	17·6865 „
40 „	18·1400 „
41 „	18·5935 „
42 „	19·0470 „
44 „	19·9540 „
45 „	20·4075 „
50 „	22·6750 „
56 „ (½ cwt.)	25·3960 „
60 „	27·2100 „
62½ „	28·3438 „
70 „	31·7450 „
75 „	34·0125 „
80 „	36·2800 „
86 „	39·0010 „
100 „	45·3517 „
108 „	48·9797 „
112 „ (1 cwt.)	50·7937 „
130 „	58·9567 „
140 „	63·4917 „
145 „	65·7592 „
150 „	68·0267 „
168 „ (1½ cwt.)	76·1897 „
170 „	77·0967 „
200 „	90·7034 „
224 „ (2 cwt.)	101·5874 „
2½ cwt.	126·9834 „
300 lb.	136·0551 „
4 cwt.	203·1748 „
450 lb.	204·0818 „
500 „	226·7585 „
5 cwt.	253·9685 „
600 lb.	272·1102 „
6 cwt.	304·7622 „
7 „	355·5559 „
800 lb.	362·8000 „
7½ cwt.	380·9528 „
8 „	406·3496 „
900 lb.	408·1636 „
1,000 „	453·5170 „
1,100 „	498·8687 „
10 cwt.	507·9370 „
12½ „	634·9204 „
1,680 lb. (15 cwt.)	761·9055 „
2,000 „	907·0340 „
1 ton (2,240 lb.)	1,015·8740 „
3,200 lb.	1,451·2544 „
3,360 „ (30 cwt.)	1,523·8110 „
35 cwt.	1,777·7795 „
4,000 lb.	1,814·0680 „
2 tons	2,031·7480 „
5,600 lb. (2½ tons)	2,539·6850 „
6,500 „	2,947·8486 „
3 tons	3,047·6220 „
4 „	4,063·4960 „
8 „	8,126·9920 „

APPROXIMATE METRIC EQUIVALENTS OF ALL ENGLISH MEASUREMENTS USED IN THIS BOOK

Linear.

English.	*Metric.*
1/10 in.	0·2540 cm.
⅛ „	0·3175 „
¼ „	0·6350 „
⅜ „	1·0525 „
7/16 „	1·1111 „
½ „	1·2700 „
⅝ „	1·5875 „
¾ „	1·9050 „
⅞ „	2·2225 „
1 „	2·5400 „
1⅛ „	2·8575 „
1 5/16 „	3·3337 „
1½ „	3·8100 „
2 „	5·0800 „
2⅜ „	6·1325 „
2½ „	6·3500 „
3 „	7·6200 „
3⅛ „	7·9375 „
3¼ „	8·2550 „
3⅜ „	8·6725 „
3½ „	8·8900 „
4 „	10·1600 „
4½ „	11·4300 „
5½ „	13·9700 „
6 „	15·2400 „
18 „	45·7200 „
24 „	60·9600 „
2½ ft.	76·2000 „
32 in.	81·2800 „
3 ft.	91·4400 „
3 ft. 4 in.	1·0160 metres
42 in.	1·0668 „
3 ft. 8 in.	1.1176 „
3 „ 11 „	1·1938 „
4 ft.	1·2192 „
5¼ „	1·6002 „
5½ „	1·6764 „
6 „	1·8288 „
8 „	2·4384 „
10 „	3·0480 „
20 „	6·0960 „
22 „	6·7056 „
24 „	7·3152 „
48 „	14·6304 „
600 „	182·8800 „

Volume.

English.	*Metric.*
⅛ fl. oz.	3·5500 c.c.
¼ „ „	7·1000 „
½ „ „	14·2000 „
¾ „ „	21·3000 „
1 „ „	28·4000 „
1¼ „ „	35·5000 „
1½ „ „	42·6000 „
2 „ „	56·8000 „
2½ „ „	71·0000 „
3 „ „	85·2000 „
4 „ „	0·1136 litres
6 „ „	0·1704 „
8 „ „	0·2272 „
10 „ „ (½ pint)	0·2840 „
15 „ „ (¾ pint)	0·3976 „
20 „ „ (1 pint)	0·5680 „
24 „ „	0·6816 „
2 pints	1·1360 „
2½ „	1·4200 „
3 „	1·7040 „
5 „	2·8400 „
1 gal. (8 pints)	4·5440 „
1¼ „	5·6800 „
1½ „	6·8160 „
2 „	9·0880 „
2½ „	11·3600 „
3 „	13·6320 „
4 „	18·1760 „
6 „	27·2640 „
8 „	36·3520 „
1,300 „	5,907·2000 „

PRESSURE EQUIVALENTS

60 lb. per square inch.	4·219 kilogrammes per square cm.
80 „ „ „ „	5·625 „ „ „ „
100 „ „ „ „	7·031 „ „ „ „
120 „ „ „ „	8·438 „ „ „ „

APPARENT SPECIFIC GRAVITY OF SUCROSE SOLUTIONS AT 20°C. WITH CORRESPONDING DEGREES BAUMÉ

Per Cent. Sucrose by Weight or Degree Brix.	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*	*Per Cent. Sucrose by Weight or Degree Brix.*	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*
0·0	1·00000	0·00	17·5	1·07195	9·72
0·5	1·00195	0·28	18·0	1·07413	10·00
1·0	1·00390	0·56	18·5	1·07633	10·27
1·5	1·00585	0·84	19·0	1·07854	10·55
2·0	1·00780	1·12	19·5	1·08075	10·82
2·5	1·00977	1·40	20·0	1·08297	11·10
3·0	1·01173	1·68	20·5	1·08521	11·37
3·5	1·01371	1·96	21·0	1·08744	11·65
4·0	1·01569	2·24	21·5	1·08969	11·92
4·5	1·01768	2·52	22·0	1·09194	12·20
5·0	1·01968	2·79	22·5	1·09420	12·47
5·5	1·02168	3·07	23·0	1·09647	12·74
6·0	1·02369	3·35	23·5	1·09875	13·02
6·5	1·02571	3·63	24·0	1·10104	13·29
7·0	1·02773	3·91	24·5	1·10334	13·57
7·5	1·02976	4·19	25·0	1·10564	13·84
8·0	1·03180	4·46	25·5	1·10795	14·11
8·5	1·03385	4·74	26·0	1·11027	14·39
9·0	1·03590	5·02	26·5	1·11260	14·66
9·5	1·03796	5·30	27·0	1·11493	14·93
10·0	1·04003	5·57	27·5	1·11728	15·20
10·5	1·04210	5·85	28·0	1·11963	15·49
11·0	1·04418	6·13	28·5	1·12200	15·75
11·5	1·04628	6·41	29·0	1·12437	16·02
12·0	1·04837	6·68	29·5	1·12675	16·29
12·5	1·05048	6·96	30·0	1·12913	16·57
13·0	1·05259	7·24	30·5	1·13153	16·84
13·5	1·05471	7·51	31·0	1·13394	17·11
14·0	1·05683	7·79	31·5	1·13635	17·38
14·5	1·05897	8·07	32·0	1·13877	17·65
15·0	1·06111	8·34	32·5	1·14121	17·92
15·5	1·06327	8·62	33·0	1·14365	18·19
16·0	1·06542	8·89	33·5	1·14610	18·46
16·5	1·06759	9·17	34·0	1·14855	18·73
17·0	1·06976	9·45	34·5	1·15102	19·00

Per Cent. Sucrose by Weight or Degree Brix.	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*	*Per Cent. Sucrose by Weight or Degree Brix.*	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*
35·0	1·15350	19·28	54·5	1·25723	29·64
35·5	1·15598	19·55	55·0	1·26007	29·90
36·0	1·15847	19·81	55·5	1·26293	30·16
36·5	1·16098	20·08	56·0	1·26580	30·42
37·0	1·16349	20·35	56·5	1·26868	30·68
37·5	1·16601	20·62	57·0	1·27156	30·94
38·0	1·16853	20·89	57·5	1·27446	31·20
38·5	1·17108	21·16	58·0	1·27736	31·46
39·0	1·17362	21·43	58·5	1·28028	31·71
39·5	1·17618	21·70	59·0	1·28320	31·97
40·0	1·17874	21·97	59·5	1·28614	32·23
40·5	1·18132	22·23	60·0	1·28908	32·49
41·0	1·18390	22·50	60·5	1·29203	32·74
41·5	1·18650	22·77	61·0	1·29498	33·00
42·0	1·18910	23·04	61·5	1·29796	33·26
42·5	1·19171	23·30	62·0	1·30093	33·51
43·0	1·19434	23·57	62·5	1·30393	33·77
43·5	1·19697	23·84	63·0	1·30694	34·02
44·0	1·19961	24·10	63·5	1·30994	34·28
44·5	1·20226	24·37	64·0	1·31297	34·53
45·0	1·20491	24·63	64·5	1·31600	34·79
45·5	1·20758	24·90	65·0	1·31905	35·04
46·0	1·21026	25·17	65·5	1·32210	35·29
46·5	1·21295	25·43	66·0	1·32516	35·55
47·0	1·21564	25·70	66·5	1·32820	35·80
47·5	1·21835	25·96	67·0	1·33129	36·05
48·0	1·22106	26·23	67·5	1·33438	36·30
48·5	1·22379	26·49	68·0	1·33748	36·55
49·0	1·22652	26·75	68·5	1·34059	36·81
49·5	1·22927	27·02	69·0	1·34371	37·06
50·0	1·23202	27·38	69·5	1·34684	37·31
50·5	1·23478	27.54	70·0	1·34997	37·56
51·0	1·23756	27·81	70·5	1·35311	37·81
51·5	1·24034	28·07	71·0	1·35627	38·06
52·0	1·24313	28·33	71·5	1·35944	38·30
52·5	1·24593	28·59	72·0	1·36261	38·55
53·0	1·24874	28·86	72·5	1·36579	38·80
53·5	1·25156	29·12	73·0	1·36900	39·05
54·0	1·25439	29·38	73·5	1·37220	39·30

Per Cent. Sucrose by Weight or Degree Brix.	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*	*Per Cent. Sucrose by Weight or Degree Brix.*	*Apparent Specific Gravity at 20°C.*	*Degrees Baumé at 20°C.*
74·0	1·37541	39·54	85·0	1·44849	44·86
74·5	1·37864	39·79	85·5	1·45192	45·09
75·0	1·38187	40·03	86·0	1·45535	45·33
75·5	1·38510	40·28	86·5	1·45880	45·57
76·0	1·38835	40·53	87·0	1·46225	45·80
76·5	1·39162	40·77	87·5	1·46572	46·03
77·0	1·39489	41·01	88·0	1·46919	46·27
77·5	1·39816	41·26	88·5	1·47268	46·50
78·0	1·40146	41·50	89·0	1·47617	46·73
78·5	1·40475	41·74	89·5	1·47967	46·97
79·0	1·40806	41·99	90·0	1·48318	47·20
79·5	1·41138	42·23	90·5	1·48670	47·43
80·0	1·41471	42·47	91·0	1·49022	47·66
80·5	1·41804	42·71	91·5	1·49376	47·89
81·0	1·42138	42·95	92·0	1·49731	48·12
81·5	1·42474	43·19	92·5	1·50086	48·35
82·0	1·42810	43·43	93·0	1·50442	48·58
82·5	1·43148	43·67	93·5	1·50800	48·81
83·0	1·43486	43·91	94·0	1·51157	49·03
83·5	1·43824	44·15	94·5	1·51517	49·26
84·0	1·44166	44·38	95·0	1·51876	49·49
84·5	1·44507	44·62			

TABLE OF COMPARATIVE CENTIGRADE AND FAHRENHEIT DEGREES

C°	*F°*	*C°*	*F°*	*C°*	*F°*
0	32·0	34	93·2	68	154·4
1	33·8	35	95·0	69	156·2
2	35·6	36	96·8	70	158·0
3	37·4	37	98·6	71	159·8
4	39·2	38	100·4	72	161·6
5	41·0	39	102·2	73	163·4
6	42·8	40	104·0	74	165·2
7	44·6	41	105·8	75	167·0
8	46·4	42	107·6	76	168·8
9	48·2	43	109·4	77	170·6
10	50·0	44	111·2	78	172·4
11	51·8	45	113·0	79	174·2
12	53·6	46	114·8	80	176·0
13	55·4	47	116·6	81	177·8
14	57·2	48	118·4	82	179·6
15	59·0	49	120·2	83	181·4
16	60·8	50	122·0	84	183·2
17	62·6	51	123·8	85	185·0
18	64·4	52	125·6	86	186·8
19	66·2	53	127·4	87	188·6
20	68·0	54	129·2	88	190·4
21	69·8	55	131·0	89	192·2
22	71·6	56	132·8	90	194·0
23	73·4	57	134·6	91	195·8
24	75·2	58	136·4	92	197·6
25	77·0	59	138·2	93	199·4
26	78·8	60	140·0	94	201·2
27	80·6	61	141·8	95	203·0
28	82·4	62	143·6	96	204·8
29	84·2	63	145·4	97	206·6
30	86·0	64	147·2	98	208·4
31	87·8	65	149·0	99	210·2
32	89·6	66	150·8	100	212·0
33	91·4	67	152·6		

INDEX

Aasted conche, 79-82
    plasticator, 81
    Trio-tanks, 83
Acidulated jellies, 177
Activated carbon, 33, 35
Agar-agar, 50
Air-conditioning, 198
Albumen whisks, 102
Alkalisation, 131
All-starch gums, 178
Almond blanching, 100
    hardbake, 114
Amino acids, 122
Aspergillus niger, 62
Automatic weighing, 110

Bacterial count, 50
Ball machine, 96
Balsam tolu, 165
Barley sugar sticks, 115
Basserin, 48
Batch roller, 94
Beeswax, 155, 165
Berry juices, 59
Blackcurrant pastilles, 174
Blackstrap molasses, 32
Blockmilk, 126, 128, 138
Bloom gelometer, 42
Borneo tallow, 59
Buttered almonds, 116
    goods, 96
Butterscotch, 116

Cacao beans, 118-121
    butter, 121-134
Cachou cutting, 105
Caramel (burnt sugar), 37
Caramels, 137
Carbon bisulphide, 66
Carraway seeds, 156
Chewing gum, 165, 203
        plant, 106
Chocolate bloom, 60
    cooling, 87, 125, 127
    "crumb," 77
    depositing, 90
    enrobing, 85-90
    mixers, 76, 121
    moulding, 90, 127, 130
Chocolate plant, 70-90
    powder, 134
    refining, 121
    tempering, 84, 123
Cinnamon chips, 156
    oil, 123, 129
Circular conche, 79
Citric acid, 62
Citrus oils, 57
    pectin jellies, 176
Cleaning and grading plant, 70
Clear fruit caramels, 138
Clear mints, 114
Clove oil, 123
Cocoa powder, 90-92, 131-134
Coconut, 64
    nuggets, 162
    oil, 60
    paste, 162
Collagen, 50
Colloids, 47, 171
Colorimeters, 45
Colour influence, 197
Compressed lozenges, 105, 160
Conching, 78, 122
Confectionery fats, 61
Continuous roaster, 70-74
    vacuum cooker, 92
Copra, 65
Corn starch, 53
    syrup, 34, 113
Cottonseed, 69
Coumarin, 58
Cream paste, 105, 161
Cream of tartar, 34, 62, 113, 167
Creamy toffees, 135-138
Cull lemons, 62

Date juice, 166
D.D.T., 66
Decorating chocolates, 89, 126
Dessert figs, 179
Dextran, 203
Dextrose, 35
    hydrate, 35, 147
"Doctors," 113
Dragée plant, 105
Dragées, 154
    chocolate, 152

Dried fruits, 66
Dry crystallising, 99

Egg albumen, 51
Electronic devices, 194
Emulsification, 69
Erythrosine, 63
Essences, 56
Essential oils, 56

Factory planning, 190
Farina, 54, 132, 161
Fat bloom, 123, 127
    determination, 132
Floral attars, 57, 160
Flours, 52
Fondant, 36, 167-170
    plant, 97
Fourrés, 170
Frappé, 141
Fruit drops, 115
    juices, 59
Fudge, 139
Fumigation, 66

Garden mint kisses, 141
Gelatin, 49, 135
    lozenges, 181
    strength, 42
Ginger jellies, 176
Glacé cherries, 63, 140
Glaze, dragée, 152
Granulation, 113, 116
Greer enrober, 86
Grinding mills, 76
Groundnuts, 69
Gum arabic, 48
    benzoin, 152
    chicle, 49, 165
    cleaning, 99
    tragacanth, 48

Hard gums, 172
    sugar goods, 113-117
        plant, 92-97
Hi-gloss cooling tunnel, 87
History, 19-28
Honey, 144
Husking and winnowing, 75
Hydraulic press, 131
Hydrogenation, 60

Illipé butter, 60
Imitation petals, 157
Infestation, 65
Instruments, 38
Inversion, 113
Invertase, 36, 167
Invert sugar, 34, 37

Jam centres, 117
Jelly beans, 178

Kirchoff, 34

Laboratory control, 193
Lactose, 36
Latent heat, 127
Lecithin, 69, 123, 129, 135
Lemonade powder, 63
Lemon oil, 57
Lemon squash gums, 173
Licorice, 65, 163
    pastilles, 183
    plant, 103
Lignin, 58
Liqueurs, 181
L.L. and C. gums, 174
L.L. and C. lozenges, 159
Lollipop attachment, 96
Longitudinal conche, 78
Lovibond tintometer, 30, 45
Lozenge drying, 159
    plant, 104

Maple sugar, 34
Marshmallow, 146
    plant, 102
Marzipan, 184-186
    plant, 91
McIntyre plant, 84
Melangeurs, 77
Methyl bromide, 66
Microfilm cooker, 93
Micron, 40
Micro-projector, 40, 123, 129
Milano paste, 187
Milk, 67, 121
    chocolate, 128
    sugar, 67
Mint lozenges, 158
Mogul starch machine, 97
Moisture determination, 45
Motion study, 191
Moulds, 98
Multi-tier cooler, 88
Musk, 57

Navarre process, 64
Noisettes, 188

Nonpareils, 156
Nougat, albumen, 143
    frappé, 145
    gelatin, 142
    malt, 145
    montèlimar, 143
    plant, 101
    wafers, 144
Nougatines, 188
Nuts, 64, 126

Ocular micrometer, 40
Oleo-palmito stearine, 60

Package design, 203-205
Paste depositing, 98
Pearling, 156
Pectins, 50
Peppermint oil, 56
Perfumed cachous, 160
*p*H determination, 41
Phenylethyl alcohol, 57
Phlobaphenes, 122
Phlobatannins, 121
Phosphatides, 69
Piping jelly, 182
Plain chocolate, 129
Plant hygiene, 193
    installation, 190
Plaques, 88
Plastic coconut, 161
Polishing dragées, 156
Ponceau 3R, 63
Potassium carbonate, 131
Potato starch, 54
Praline, 186
Pre-bottoming attachment, 86
Production planning, 196
Protein nougat, 145

Quality control, 196

Radio frequency heating, 195
Rape seed, 69
Refractometer, 41, 51
Refrigerated cold slab, 86
Refrigeration plant, 89
"Rema" cocoa plant, 90, 132
Research, 202
Roasting, 121
Rostoplast, 95

Saccharimeter, 43
Safety measures, 192
Schaum mallow, 148
Silver dragées, 106, 153
Sirocco roasters, 70
Slab toffee, 137
Soft sugar coating, 155
Soluble solids, 41
Soya beans, 69
Soy albumen, 52
SO_2, 59, 66
Spearmint oil, 56
Spectrophotometry, 45
Spermaceti, 155
Starch conditioning, 100
Steam roasters, 74
Stearine, 160
Stoves, drying, 101
Sucrose, 29-33
Sugar bloom, 69, 127
Sugared almonds, 150
Sugar pulverising, 110
Sylkonche, 79
Synthetic attars, 57
    fats, 61
Syrup bob, 147
    crystallisation, 99

Tangerine jellies, 175
Tapioca flakes, 157
Tartaric acid, 62, 131
Testing, chocolate, 40
    pectin jellies, 42
Thin boiling starch, 53
Toffee mints, 102
    plant, 139
Tragacanthin, 48
Turkish delight, 180

Ultrasonic conching, 83, 206
Ultrasonics, 205

Vacuum batch cooker, 93
    drying, 77
    kneader, 76, 129
Vanillin, 58, 123, 129
Viscometer, Macmichael, 39
Viscosity, 39, 69
Volatile fatty acids, 79

Wafer biscuits, 145
Walnuts, 65
Whey concentrate, 37, 203
Wrapping machines, 107-110

X-rays inspection, 195

Yeast cells, 67

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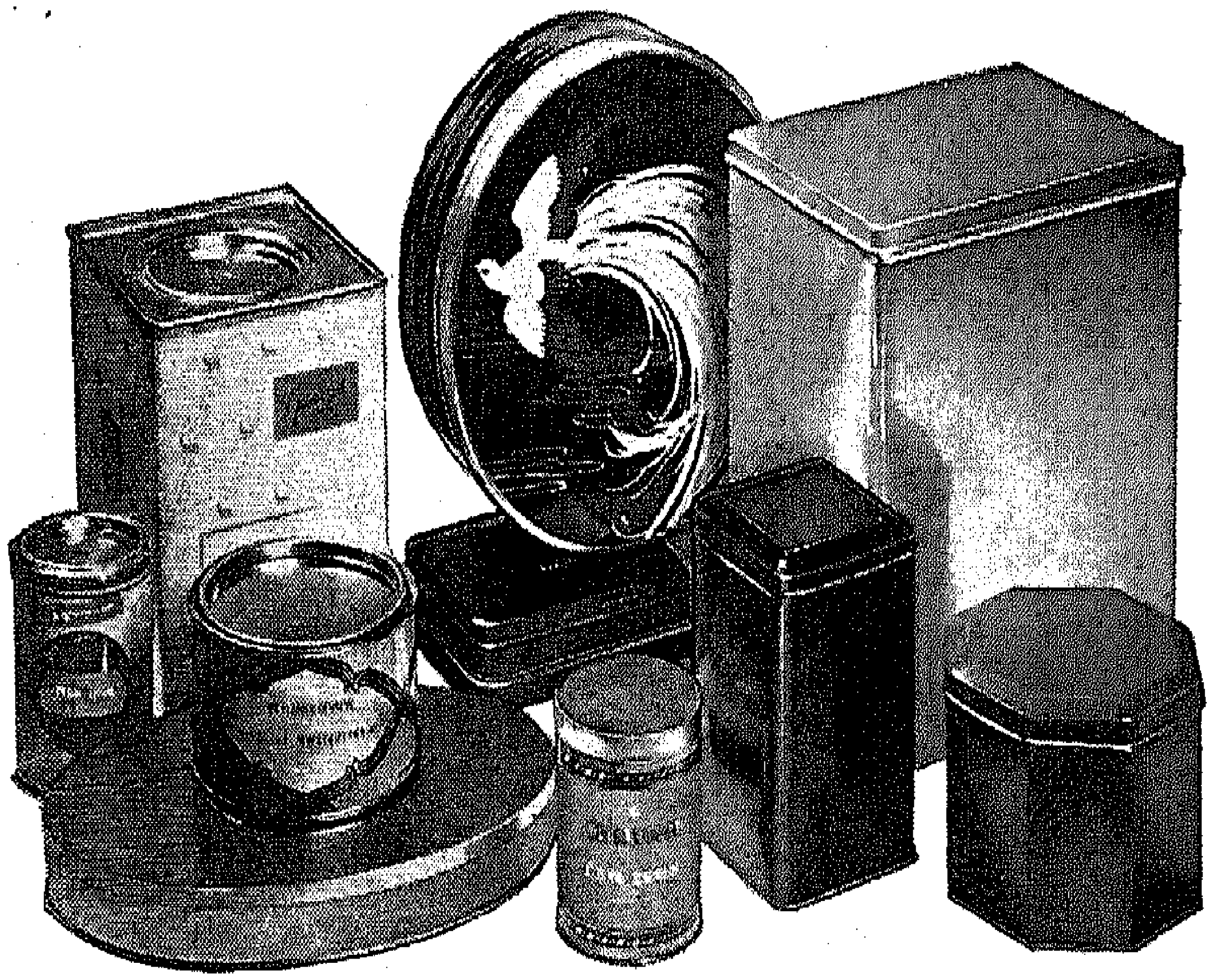

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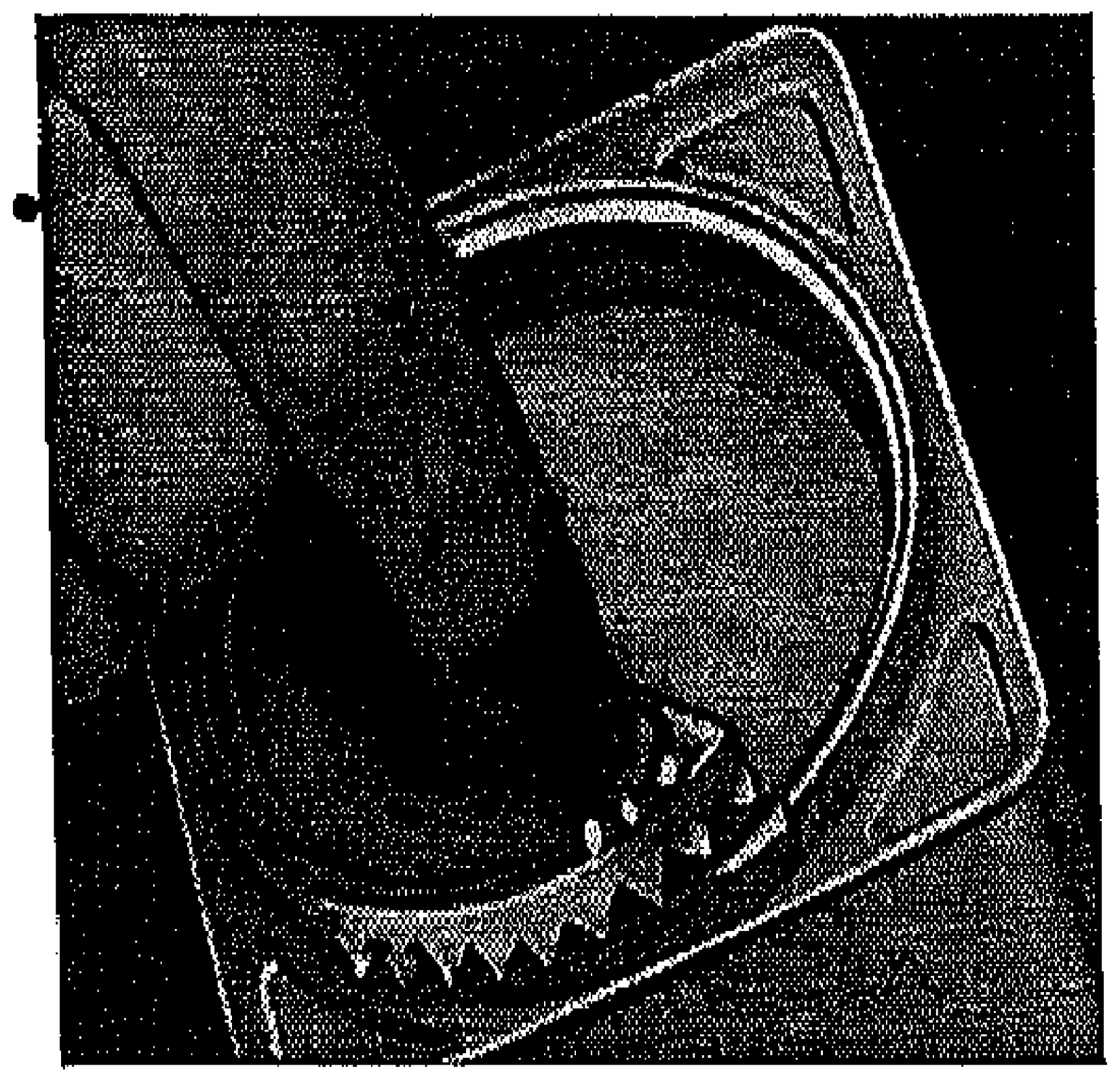

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P

Nonpareils, 156
Nougat, albumen, 143
  frappé, 145
  gelatin, 142
  malt, 145
  montélimar, 143
  plant, 101
  wafers, 144
Nougatines, 188
Nuts, 64, 126

Ocular micrometer, 40
Oleo-palmito stearine, 60

Package design, 203-205
Paste depositing, 98
Pearling, 156
Pectins, 50
Peppermint oil, 56
Perfumed cachous, 160
*p*H determination, 41
Phenylethyl alcohol, 57
Phlobaphenes, 122
Phlobatannins, 121
Phosphatides, 69
Piping jelly, 182
Plain chocolate, 129
Plant hygiene, 193
  installation, 190
Plaques, 88
Plastic coconut, 161
Polishing dragées, 156
Ponceau 3R, 63
Potassium carbonate, 131
Potato starch, 54
Praline, 186
Pre-bottoming attachment, 86
Production planning, 196
Protein nougat, 145

Quality control, 196

Radio frequency heating, 195
Rape seed, 69
Refractometer, 41, 51
Refrigerated cold slab, 86
Refrigeration plant, 89
"Rema" cocoa plant, 90, 132
Research, 202
Roasting, 121
Rostoplast, 95

Saccharimeter, 43
Safety measures, 192
Schaum mallow, 148
Silver dragées, 106, 153
Sirocco roasters, 70
Slab toffee, 137
Soft sugar coating, 155
Soluble solids, 41
Soya beans, 69
Soy albumen, 52
SO_2, 59, 66
Spearmint oil, 56
Spectrophotometry, 45
Spermaceti, 155
Starch conditioning, 100
Steam roasters, 74
Stearine, 160
Stoves, drying, 101
Sucrose, 29-33
Sugar bloom, 69, 127
Sugared almonds, 150
Sugar pulverising, 110
Sylkonche, 79
Synthetic attars, 57
  fats, 61
Syrup bob, 147
  crystallisation, 99

Tangerine jellies, 175
Tapioca flakes, 157
Tartaric acid, 62, 131
Testing, chocolate, 40
  pectin jellies, 42
Thin boiling starch, 53
Toffee mints, 102
  plant, 139
Tragacanthin, 48
Turkish delight, 180

Ultrasonic conching, 83, 206
Ultrasonics, 205

Vacuum batch cooker, 93
  drying, 77
  kneader, 76, 129
Vanillin, 58, 123, 129
Viscometer, Macmichael, 39
Viscosity, 39, 69
Volatile fatty acids, 79

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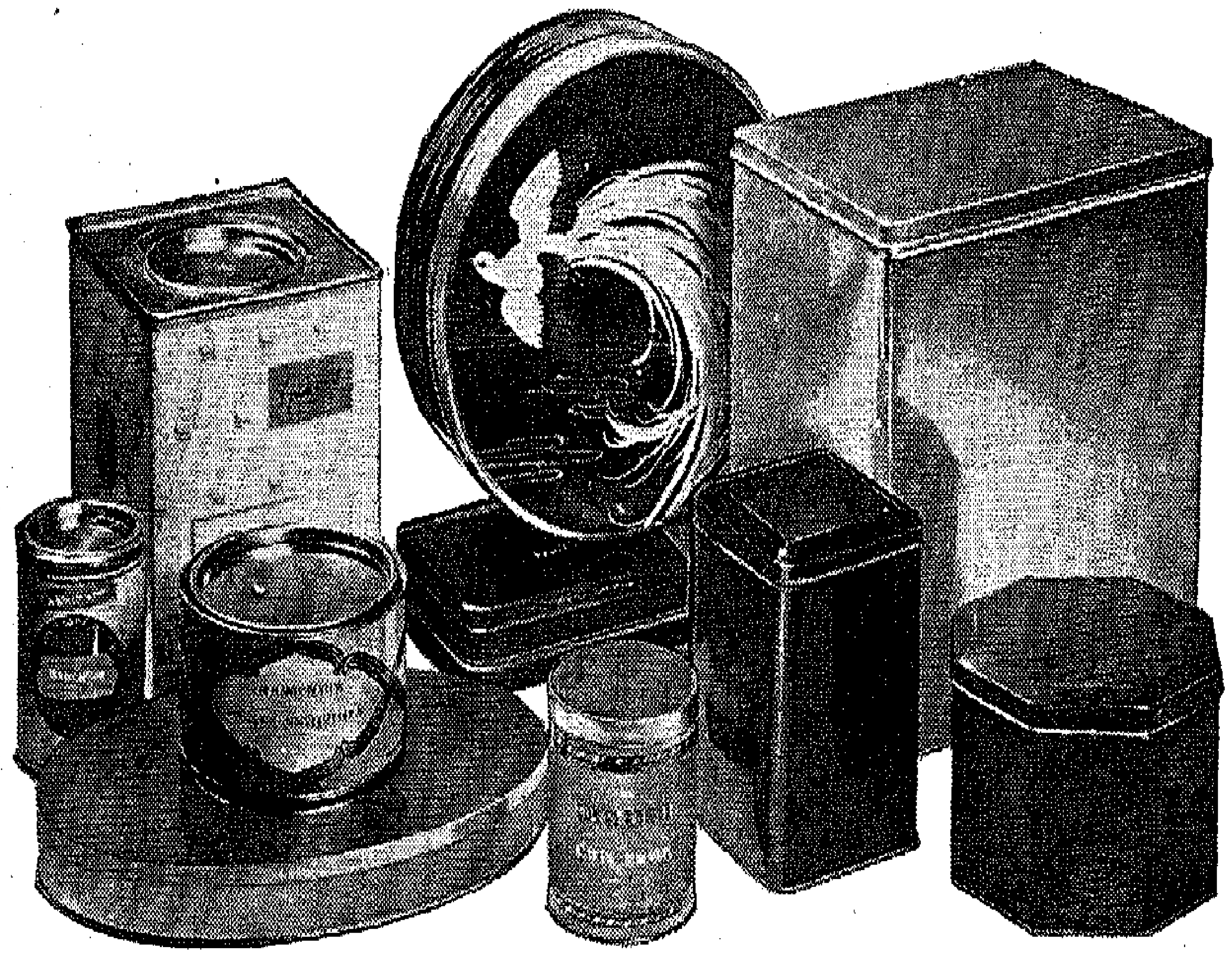

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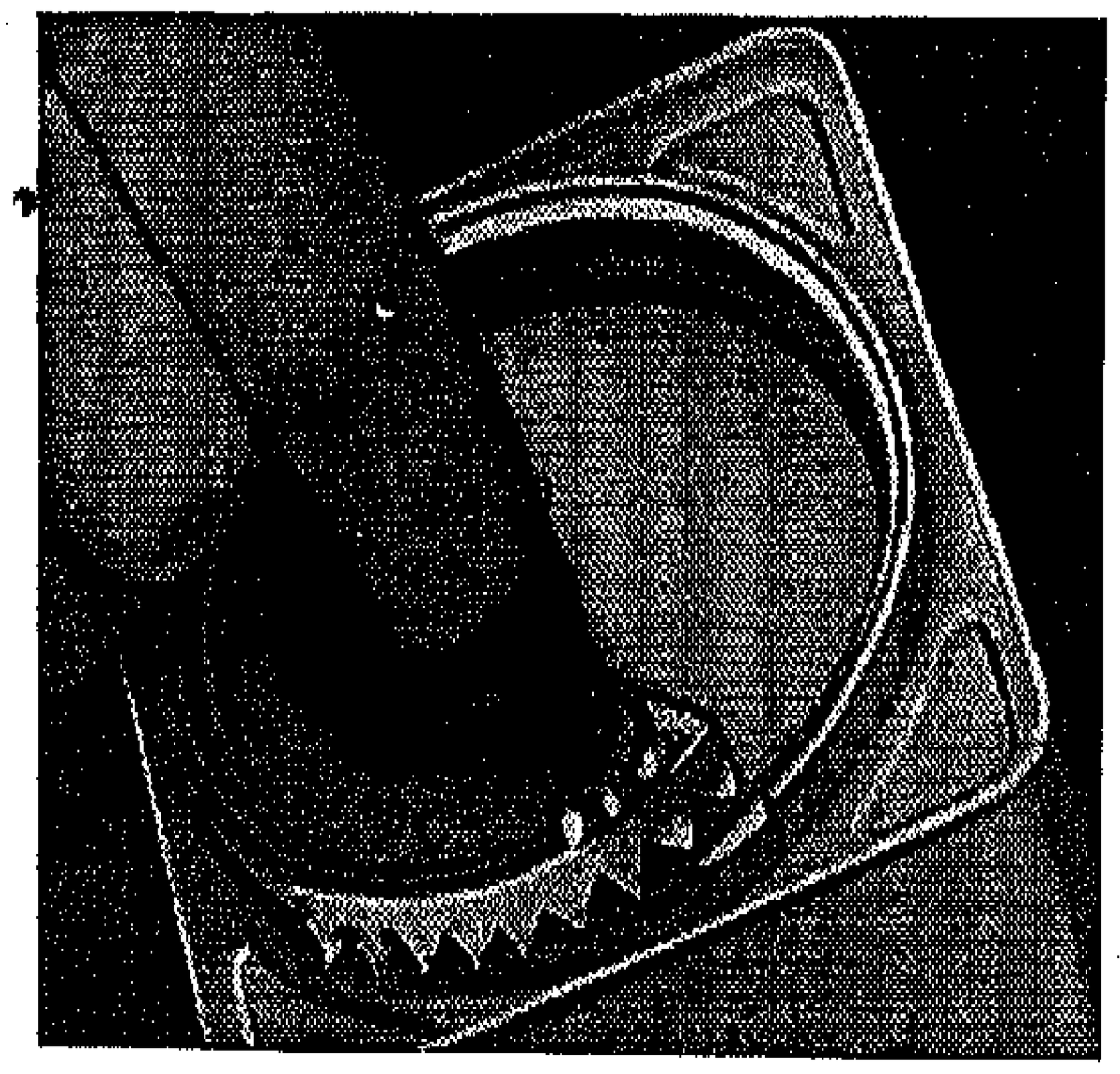

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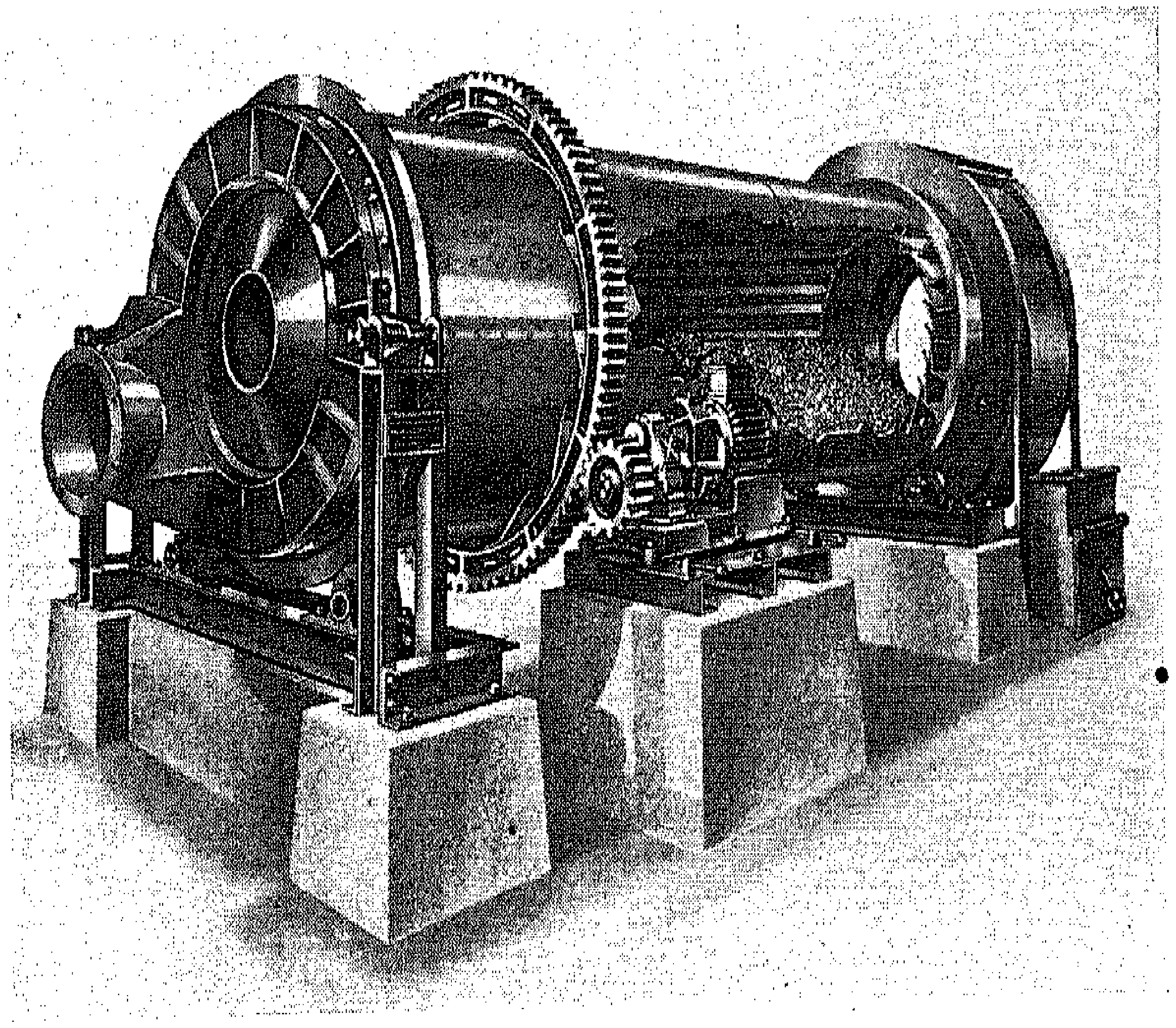

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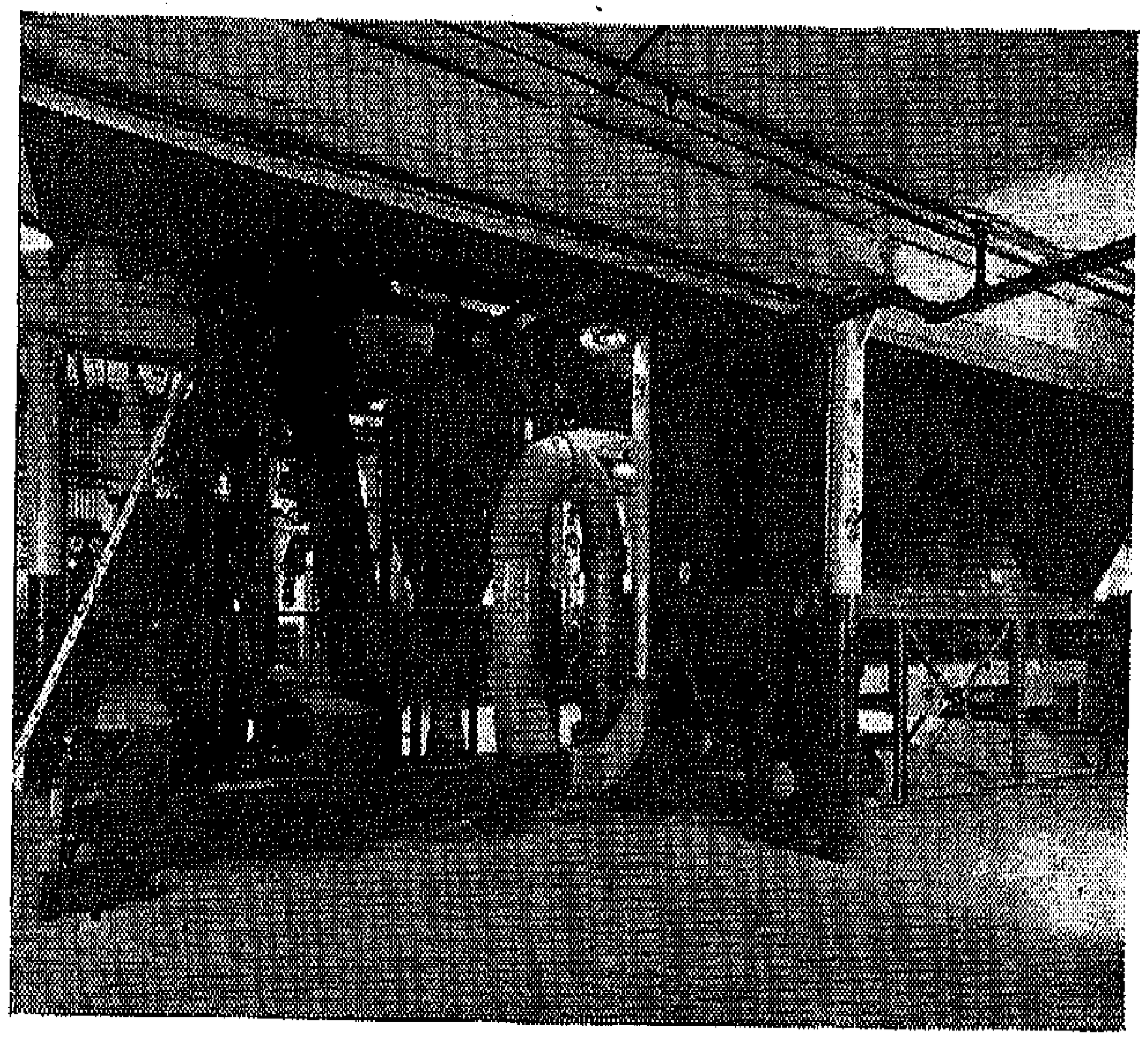

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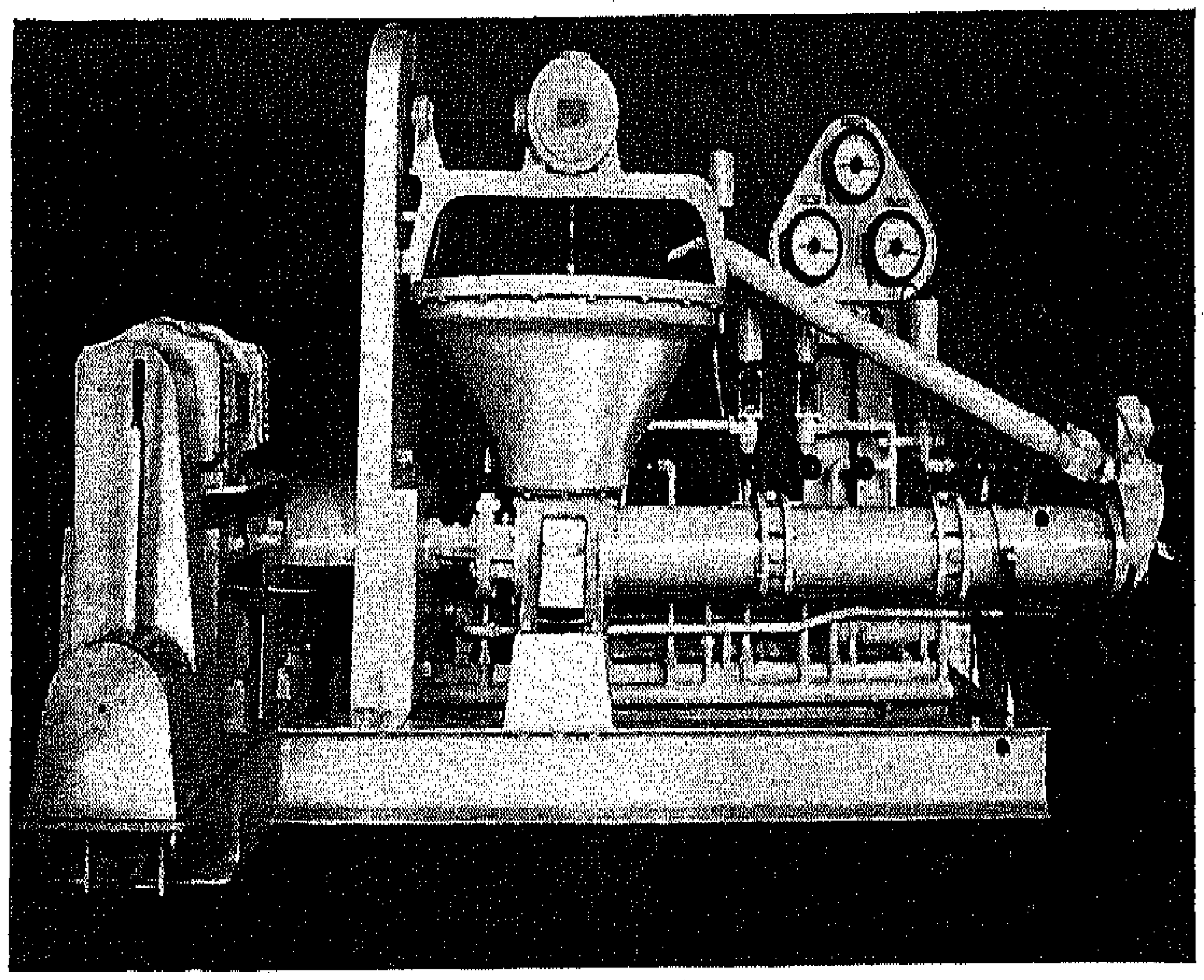

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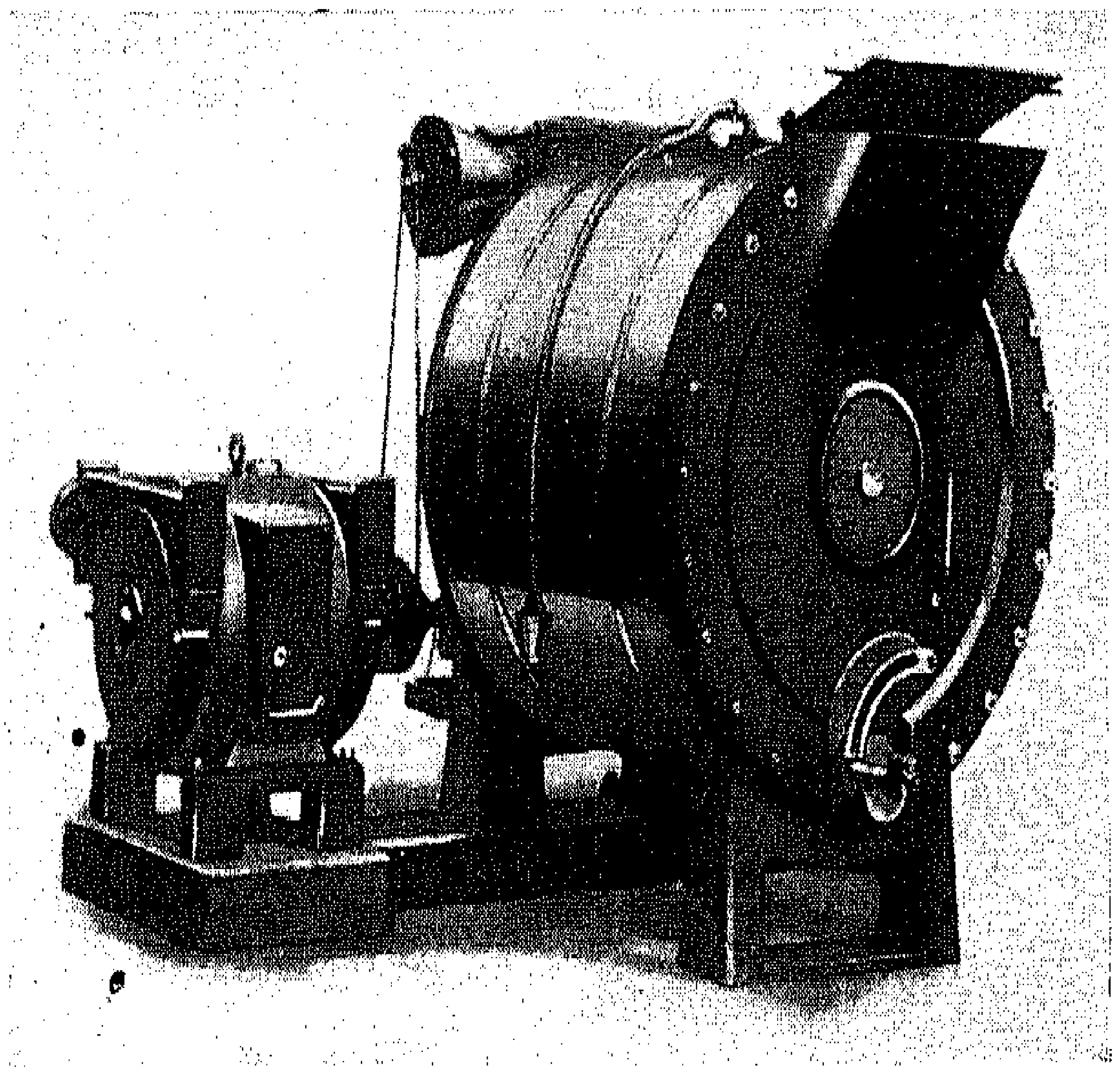

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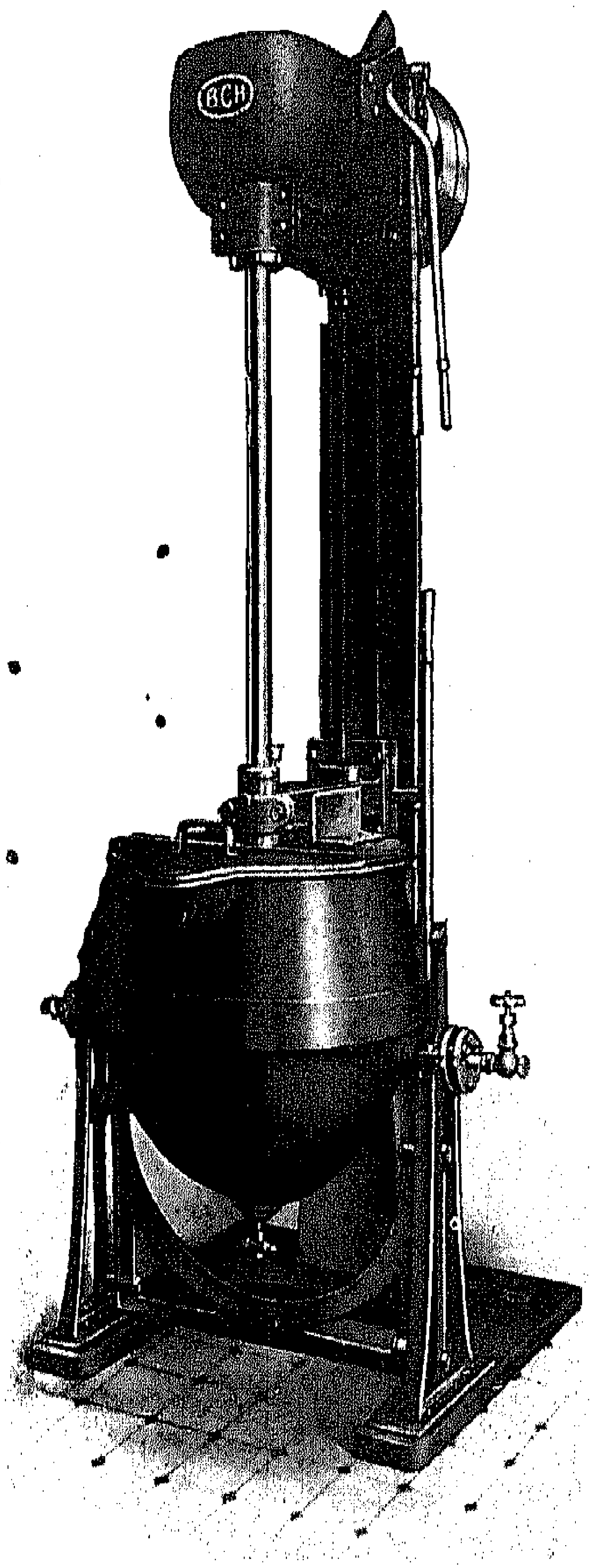

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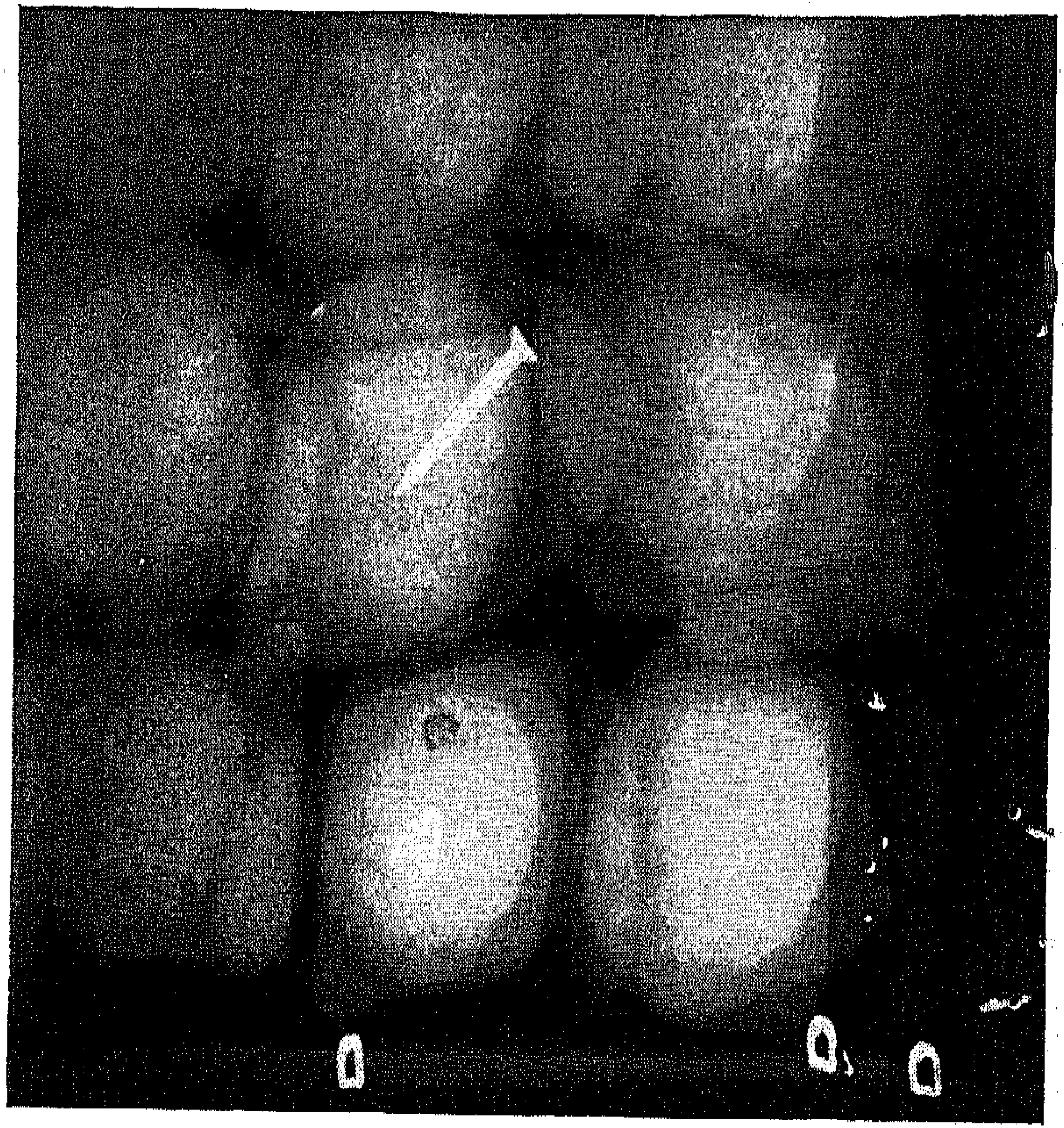

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6

TRICKY VERBS—HANDLE WITH CARE

A SCHOOLBOY'S AMUSING ERROR

There is a story about a schoolboy who was in the habit of saying "I have went" instead of "I have gone." One day his teacher ordered him to stay after school and to write "I have gone" three hundred times on the blackboard.

The boy faithfully completed his task, and then left the following note for his teacher:

"Dear Teacher—I have finished my work and I have went home."

Watch out for bad habits in the usage of your verbs. Such habits are not easy to break. You have learned, in Chapter 5, how to avoid confusion in *lay* and *lie*. In addition to these, there are many other verbs that can play various tricks with our language. This is what makes English so fascinating a study to natives and to foreigners alike.

WHERE LOGIC IS MISLEADING

A German refugee recently prepared a list of parallel verbs whose principal parts he constructed, as he said, in accordance with the "rules of logic." Here are just a few of these words:

I eat	I ate	I have eaten
I treat	I treat	I have treaten
I steal	I stole	I have stolen
I heal	I hole	I have holen
I drink	I drank	I have drunk
I think	I thank	I have thunk
I see	I saw	I have seen
I flee	I flaw	I have fleen
I take	I took	I have taken
I make	I mook	I have maken
I teach	I taught	I have taught
I bleach	I blaught	I have blaught

You can devise for yourself any number of equally absurd principal parts that might appear to be based upon the "rules of logic." Our language, however, is not always logical. Words are not hammered out like pieces of iron on a machine. They grow and change over the centuries, and many of them have assumed forms that are quite irregular. Thus we have, in addition to *regular verbs*, a number of *irregular verbs*.

The principal parts of the *regular verbs* are easy enough to remember. For example:

I help	I helped	I have helped
I miss	I missed	I have missed
I pray	I prayed	I have prayed

It is the *irregular verbs* that are troublesome. Each of them is a law unto itself. Many errors are made in the daily usage of these verbs.

Some of these errors are to be found in several of the following sentences. See if you can spot them in those sentences that are incorrect.

FIND THE ERRORS

1. Now you have gone to work and have did it again.
2. She has broke her promise a number of times.
3. They have froze their toes in the blizzard.
4. The artist has drawn a good likeness of the model.
5. A serious crisis has arisen in the world as a result of the splitting of the atom.
6. Very few people have swam the English Channel.
7. Johnny is sorry he has tore his sweater.
8. I have never drove such a comfortable car.
9. The choir has sung the *Messiah*.
10. They have spoke very well of you.

—Answers—

Sentences 4, 5 and 9 are correct. The others should be corrected as follows:

1. Now you have gone to work and have *done* it again.
2. She has *broken* her promise a number of times.
3. They have *frozen* their toes in the blizzard.
6. Very few people have *swum* the English Channel.

7. Johnny is sorry he has *torn* his sweater.
8. I have never *driven* such a comfortable car.
10. They have *spoken* very well of you.

SIMPLE WORDS WITH SURPRISING TWISTS

To avoid such errors as the above, learn the principal parts of these tricky verbs:

Present	*Past*	*Present-Perfect*
I arise	I arose	I have arisen
I bear	I bore	I have borne
I beat	I beat	I have beaten
I become	I became	I have become
I begin	I began	I have begun
I bid (*in buying*)	I bid	I have bid
I bid (command)	I bade	I have bidden
I bite	I bit	I have bitten
I blow	I blew	I have blown
I break	I broke	I have broken
I burst	I burst	I have burst
I choose	I chose	I have chosen
I come	I came	I have come
I deal	I dealt	I have dealt
I do	I did	I have done
I draw	I drew	I have drawn
I drive	I drove	I have driven
I eat	I ate	I have eaten
I fall	I fell	I have fallen
I fly	I flew	I have flown
I forbid	I forbade	I have forbidden
I forsake	I forsook	I have forsaken
I freeze	I froze	I have frozen
I get	I got	I have got, gotten
I give	I gave	I have given
I go	I went	I have gone
I grow	I grew	I have grown
I hurt	I hurt	I have hurt
I lead	I led	I have led
I ride	I rode	I have ridden
I run	I ran	I have run
I see	I saw	I have seen
I set	I set	I have set
I sing	I sang	I have sung
I sit	I sat	I have sat
I slay	I slew	I have slain
I sling	I slung	I have slung
I speak	I spoke	I have spoken
I spin	I spun	I have spun
I string	I strung	I have strung
I strive	I strove	I have striven
I swim	I swam	I have swum
I tear	I tore	I have torn
I wring	I wrung	I have wrung
I write	I wrote	I have written

And please note the following verb:

I hang	I hung, or I hanged	I have hung, or I have hanged

When a criminal is executed by hanging, he is *hanged.*
When a thing is suspended, it is *hung.*

QUIZ TIME

Now for a round-up to see how well you've learned these principal parts. Check those of the following sentences that are wrong, and correct the errors:

1. "You shouldn't of did it," said Mrs. Smith to Jerry.
2. The dancers spinned around in a circle.
3. She is sorry she has broken the pitcher.
4. I'm afraid I have bited off more than I can chew.
5. "I have hurted my toe!" cried little Peter.
6. They have ridden 400 miles between sunrise and sunset.
7. He begun the job with the greatest enthusiasm.
8. "You have run an excellent race," said the coach.
9. "I have strove to do my best," replied the captain of the track team.
10. I seen a suspicious character on the street corner.

CORRECTIONS

1. "You shouldn't have done it," said Mrs. Smith to Jerry.
2. The dancers spun around in a circle.
4. I'm afraid I have bitten off more than I can chew.
5. "I have hurt my toe!" cried little Peter.
7. He began the job with the greatest enthusiasm.
9. "I have striven to do my best," replied the captain of the track team.